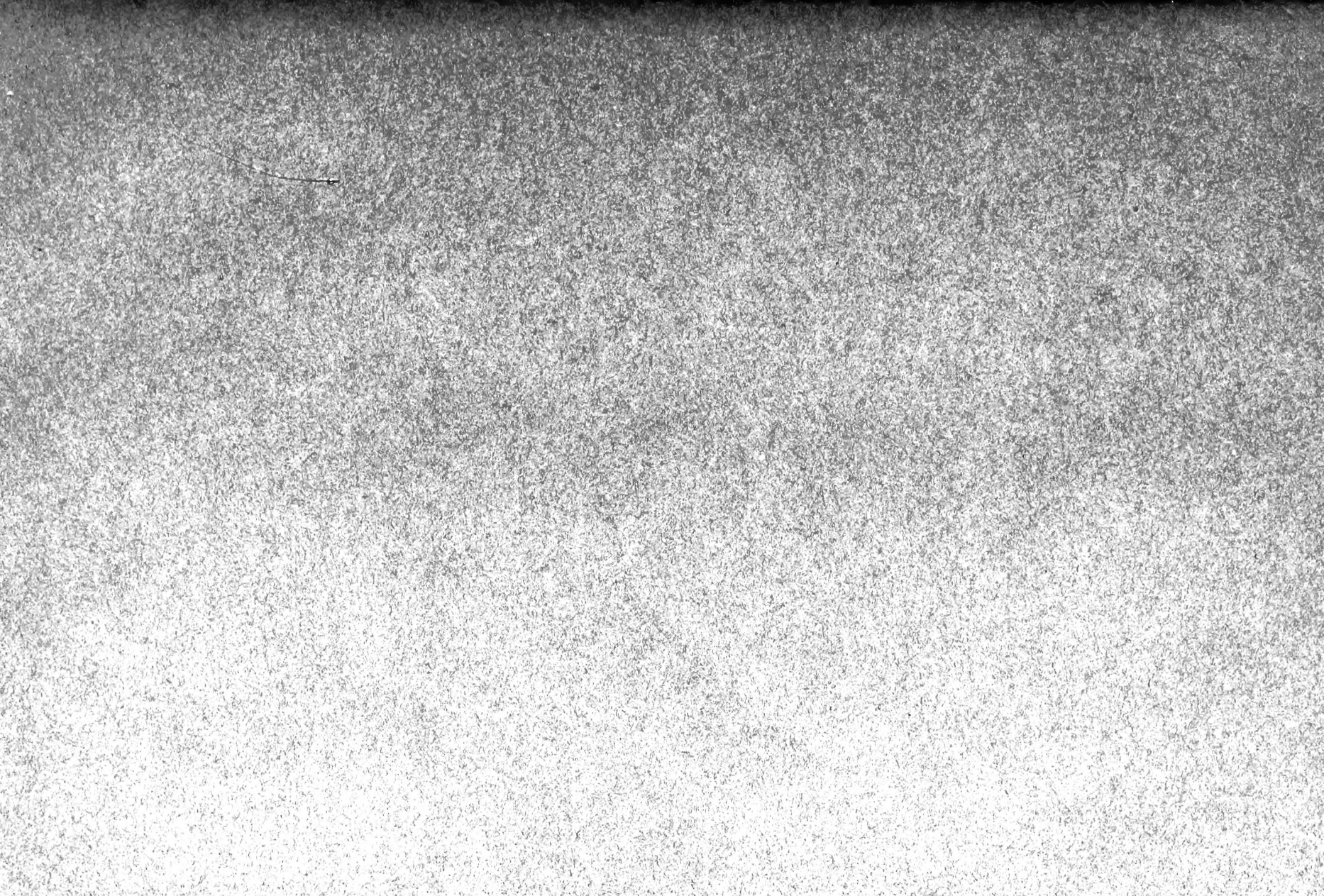

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
WATERSHED MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
RANGE MANAGEMENT
FOREST SURVEY

APR 1940

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Dr. Spaulding
Dr. R.C. Brown

FOREST RESEARCH

BI-MONTHLY REPORT

April 1, 1940

GENERAL

Allegheny

Personnel. T. E. Maki arrived to take charge of the proposed central laboratory at Beltsville. C. N. Morang was added to the Regional staff as hydrologist. B. C. Goodell was transferred as of April 1 to The Intermountain Forest Experiment Station, on forest influences work.

Survey Headquarters Established. The anthracite Survey occupied field headquarters in the Kingston Branch Post Office in Wilkes Barre on February 15.

Cooperation. Shirley and Little attended a meeting of the State Land Use Planning Committee in New Brunswick, New Jersey. Interest in farm forestry was expressed by farmer representatives. The Committee adopted a report calling for the expenditure of $1,000,000 for State acquisition of forest lands in the pine barren area and plans to assist State Forester Wilbor in securing legislation providing appropriations for this purpose.

The Station was asked to prepare a plan for studying the cost of producing pulpwood, work to be done on lands of the Armstrong Forest Company, in cooperation with State and Private Forestry. Advice as to the possibility of growing Rhus, required for tanning in eastern Pennsylvania and Maryland, was requested by a company producing tanning extracts in the Philadelphia area.

A. R. Spillers, of Region 7, discussed forest problems in the Station territory, and E. Ritter was detailed to the Station to prepare a report covering fire protection improvements needed in the Wyoming Valley section of the anthracite region. Arrangements were made with the Soil Conservation Service to obtain information on markets for farm forest products in the region in and adjacent to the Farm Forestry projects in Maryland and Pennsylvania.

Appalachian

Personnel. E. D. Marshall, M. D. Hoover, and J. R. Scott have reported for duty on the Forest Influences project.

Central States

Meetings. Farmers Week was held at Ohio State University from January 29 to February 3. A paper entitled "What can be done

to regain hardwood markets for session. In the evening after the banquet the group heard Dr. Paul B. Sears and enjoyed a wild-life slide lecture by Dr. L. E. Hicks.

Representatives of the Soil Conservation Service, Extension Service, Bureau of Agricultural Economics, and the Station met on March 7 to plan for a forestry school in cooperation with the Ross County Planning Committee to train the township ACP committeemen in simple stand improvement practices. Topics were discussed and arranged so as to place emphasis on improvement of existing woodlands rather than on tree planting. Residual forest now occurs in Ross County on 3 or 4 acres for every acre likely to be planted by owners. Plans included one day of talks and three of woods demonstration in different portions of the county.

On March 26 - 29 the meetings were held. Speakers were provided by the Ohio Division of Forestry, Extension Service, Wayne National Forest, Central States Forest Experiment Station, and Soil Conservation Service. Demonstration areas to provide basis for the discussion of needed improvements and planting had been chosen in northwestern Ross County, at the Scioto State Forest, and in southwestern Ross County. Another meeting is planned next autumn just before the winter season when the woods work is most likely to be undertaken.

On February 26, Hall addressed the Agricultural Faculty of Purdue on the subject, "Wood in a Chemical World."

Auten lectured before the Plant Institute of the Ohio Agricultural Experiment Station at Wooster, Ohio, February 26, on "Relationship of forest profile to reforestation."

Cooperative Farm Forestry. During February, plans for a marketing study were completed and approved by the Missouri Farm Forestry Committee. Although this project was submitted to the Departmental Committee for approval, it was too late for inclusion in this year's research allotment from Norris-Doxey funds.

Similarly, a project to determine the growth and yield of white oak in Iowa was arranged in February by the Iowa Agricultural Experiment Station and Central States Station; but funds were exhausted. Iowa has mapped out a long-time farm woods research plan which is very creditable.

The Ohio Farm Forestry Committee met at the office of Dr. Ramsower on March 6, to give final review to the Ohio Farm Forestry Plan. Slight changes and corrections were made and the agreement between the State and SCS was reviewed and accepted by State Forester Alderman. This action paved the way for release of funds for the approved research project to support the Ohio Woodland Survey.

Personnel. A. G. Adman returned to the Station to engage in statistical analysis of back and current project work. With the completion of the St. Francis Survey the Flood Control organization at the Central States Station has been reduced to four men, Day, Steddard, Wood, and Bixby.

Branch Stations. Members of the Forest Supervisor's office of the Wayne National Forest and of this Station made a 2-day trip into southeastern Ohio to explore for a suitable location for a branch station within the Federal purchase boundaries. The proposed Richland Furnace tract in Vinton and Jackson counties, charcoal furnace lands farther south in Lawrence county which already have been purchased and the Little Muskingum river drainage were considered.

Lake States

Sleet damages Cutfoot Experimental Forest. Word was received from Supervisor Knutson that a sleet storm caused enormous damage to the Chippewa Forest on April 2 and that the Cutfoot Experimental Forest was in the center of the storm area. It is estimated, on the basis of an ocular survey, that 10 million feet of timber is down. In addition, there is untold injury to young growth. Pole stands of jack pine were especially severely hit with perhaps 30-to 35-percent loss in trees 25 to 50 years old. Red pine did not fare nearly as badly.

On the basis of preliminary examination of experimental cuttings by Eyre, it appears that a good many plots will have to be abandoned. A timely reference can be made to "Do we have too many eggs in one basket?" in the February 1939 issue of the Bimonthly Report. So far as the station is aware, no comments were made on this article.

Meetings. Zon and Cunningham were made members of a Timber Resources Committee of the Minnesota State Planning Board. The Committee plans to publish a simple readable report on the state's timber resources emphasizing the possibilities of increasing and stabilizing employment in forest industries.

Cooperation. The Station has been conferring with the Forest Products Laboratory, the Regional Office, the University of Wisconsin, and the Northern Hemlock and Hardwood Association concerning possible surveys of small sawmills preparatory to organization of the small operators for improved manufacturing and marketing.

Pacific Northwest

Personnel. Ernest L. Kolbe left the Station April 1 by transfer to Flood Control Surveys at the California Forest Experiment Station after 11½ years here. Most of that time he has been assigned to the silviculture of ponderosa pine; as side lines he has given enthusiastic leadership to the phenology project and to the dendrology and arboreta projects. The development of the Pringle Falls and Blue Mountain Experimental Forests is a credit to his workmanship and immediate direction.

Meetings. Munger attended the annual Washington State Forestry Conference in Seattle and gave a paper, by request, on sustained yield and taxation.

Lodewick represented the Station at the Third Oregon Air Conditioning Conference held in Corvallis, March 28-30. At the request of the program committee he presented an hour's paper at one of the general sessions on the subject "Moisture Condensation in Buildings." This subject is of timely interest to architects because with increased use of air conditioning and construction designed to decrease heat losses and air infiltration, condensation problems are arising even in mild climates such as those experienced in the Pacific Northwest. A great deal of interest was shown by the 150 air-conditioning engineers and architects present.

Within recent months the carbonization of wood and the utilization of the products of carbonization have been active subjects. The staff has spent a considerable portion of its time in conference with various interested individuals and groups. At least four men in the Portland area have retorts and processes for which they are trying to find "angels"; one lumber company has obtained a War Department educational order for gas mask charcoal made from fir waste; some groups are interested from the standpoint of waste utilization, either of existing non-utilized woods and mill by-products or of waste now utilized for the production of electric power but that may be thrown back on the market when Bonneville hook-ups are completed. Most of the interest centers around the use of the charcoal in steel production or as a domestic fuel.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Inventory. Inventory field work was resumed late in February after a lapse of more than a year. A training school was established in Emporia, Virginia, to familiarize new men with the species and with Survey technique. After a week of training, line plot work was started in the Coastal Plain unit with five 3-man crews. By the end of March over 200 miles of line had been run. Barring unfavorable weather conditions, this 6½-million-acre unit should be completed early in June and the crews will then begin work in the Piedmont region of the State.

Computation. At the request of the Flood Control Survey organization of the Stanton data on forest area, volume, growth, and drain were compiled for the entire watershed of the Yadkin-Pee Dee River. This watershed extends through portions of three Forest Survey units in North Carolina and one in South Carolina. As the inventory data were recorded by counties on punch cards, it was possible to sort out and tabulate by machine the data for the counties in the watershed. By this means, Flood Control Survey obtained accurate information on the forest resources at a small fraction of the cost of making a field survey.

Reports. Forest Survey Release No. 4, "Forest Resources of the Southern Coastal Plain of North Carolina", was issued late in March. This report shows that two-thirds of this 8-million-acre unit is forested. The total saw-timber volume was 12¼ billion board feet (International ¼-inch scale) with loblolly pine accounting for half of the volume. The stands are predominantly second-growth. Nearly 40 percent of the pine saw-timber volume is in trees less than 14 inches and 60 percent of the hardwood volume is in trees less than 20 inches in diameter. Considering all trees 5 inches d.b.h. and larger, the area contains 67 million cords of wood about half of which is pine. Red and black gum are the principal hardwood species.

Approximately 500 primary wood-using plants operated in the unit in 1937 and furnished 3¼ million man-days of lumber. The total drain on saw-timber growing stock was nearly 600 million board feet.

Although net increment exceeded drain in the unit, the report points out that the cut is concentrated on the more desirable species and high quality trees, whereas the increment was for all trees. More intensive fire protection, research in timber

management, increased utilization of black and tupelo gum and the development of a more stabilized sawmill industry are recommended as measures for improving forest conditions.

Lake States

H. G. White was in Washington the latter half of March in connection with census cooperation and development of plans for keeping Forest Survey drain figures up-to-date.

Cunningham led the discussion at the March 28 station seminar, the subject being "Possibilities of the Gallup technique for obtaining forest statistics." Tests have shown that regional forest inventories based upon line plot surveys can be strengthened and made applicable to smaller survey units by a system of stratification based upon cover type maps. Detailed type maps are rapidly becoming available for most of the Lake States Region. Stratification and double-sampling also can be used in the growth and drain phases of the Forest Survey.

Northern Rocky Mountain

General. Comments by the reviewers on the manuscript "Forest Increment in North Idaho" have been received and the authors are in the final stages of revising the report for publication.

Good progress has been made during February and March in inventory and growth, the work having developed more rapidly than anticipated.

Depletion. The average annual fire depletion for the period 1931-37, inclusive, by survey type classifications, has been determined for 4 counties. The average yearly fire depletion on unreserved commercial forest lands in Lincoln County was as follows:

Ownership class	Area burned over	Area deforested	Volume affected by fire		Volume killed	
	Acres	Acres	M bd.ft.1/	M cu.ft.2/	M bd.ft.1/	M cu.ft.2/
National forest land	3,649	3,205	34,969	14,486	30,161	11,768
Other land	522	471	927	417	640	335

1/ Board feet Scribner rule.
2/ Includes only the volume of trees larger than 5.5 inches d.b.h. below a 4-inch top diameter.

Pacific Northwest

Douglas Fir Region

Inventory Revision Progress. A week of clear weather afforded an opportunity to revise the type map of Washington County for the area within the disastrous Saddle Mountain and Dutch Canyon fires. Both these fires occurred late in the year after field work was completed in this county. At the same time cutting records were brought up to date for Washington County and Lewis County. Compilation of forest type areas is now well under way in these two counties and when released these data will be current as of March 1, 1940.

Reports for Coos County, Oregon, and Thurston County, Washington, were completed. The Cowlitz County report is complete and will be ready for distribution as soon as the cover, tables, and graphs are multilithed.

Ponderosa Pine Region

Comments are being received on the regional report from Station and Regional Office staff members and as soon as all are in they will be correlated and corrections made in the manuscript preparatory to transmittal to Washington.

Results of the Reinventory. Cowlitz County, the latest to be completed for publication, offers a contrast to others in the region in the extent and character of its second-growth stands. Nearly half of its forest land is occupied by second growth and approximately three-fifths of the second-growth stands are well stocked. The saw-timber area amounts to slightly over a third of the total forest land. Recent and nonrestocked cutovers and deforested burns total one-sixth of the forest land. Saw-timber volume amounted to 15.9 billion board feet in 1939, a reduction of 2.7 billion board feet since the 1933 inventory. Two large operations are located in the county and it is anticipated that depletion will be maintained at a high level for many years to come. Concentration of timber ownership in strong hands, a large supply of advance second growth, and forest land of high productive capacity offer encouragement for a permanent forest industry here.

Southern

General. On February 1, Eldredge addressed the joint meeting of the American Forestry Association and Mississippi Forestry Association, at Biloxi, Miss., on "The forest resources of the South and their industrial significance." On March 28, he spoke before

the Southern Pine Association at New Orleans, La., in a talk entitled "Out stock in trade."

On March 29, Ineson addressed the Alabama Academy of Science at Birmingham, on "The forest economy of Alabama."

Of special interest during the past year has been the interest shown by extension and state foresters, planning board personnel, and others similarly engaged, in three sets of charts summarizing Forest Survey findings and other data for the states of Georgia, Mississippi, and Alabama. The Alabama set of charts was used by Ineson at Birmingham, and he was immediately pressed with requests for loan of the originals, or for copies. Wheeler had much the same experience some months ago at a meeting in Mississippi, when the Mississippi originals were borrowed by Henry Crosby, President of the Mississippi Forestry Association, immediately after their initial showing, and taken on an extended tour around the State.

Ward was transferred to duty on the Ouachita National Forest, on February 15.

Davis completed a site index map for pine for the State of Georgia, has a similar map for Alabama under way, and plans slight revision of the pine site index map for Florida (the first map of this nature, and which was prepared by Ineson).

Considerable miscellaneous Survey correspondence was prepared, much of it requiring special Survey data. Examples are: data for a report on the hardwoods of Louisiana being prepared by the Louisiana State Department of Commerce; a summary of forest inventory, growth and drain being prepared by the Louisiana Public Service Commission; an allocation of the cordwood volume in the area surrounding Beaumont within radii of 50, 75, and 100 miles; location of commercial stands of white pine and hemlock in Alabama and Georgia for the Census; and requests for volume tables.

A news note, "Growth, mortality, and utilization drain in Southern territory, 1936-37," was prepared for Southern Forestry Notes, by Stover.

Smith and his assistants were engaged during much of the period in a cooperative project in which Census forest-industry questionaires for Mississippi, Georgia, and Florida were routed through this office for editing.

Census tabulations, for Southern territory, of 1938 lumber production by county were received from Washington and allocation made from them to the various survey units.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Taxation. Wyckoff has been active as chairman of the Portland Chamber of Commerce Subcommittee on Forest Taxation of the Forestry Committee, which is studying the growing opposition to the Oregon yield tax law. Subsequent to the 1940 hearings on lands proposed for classification under the Oregon yield tax law about 63,000 acres were classified. All classification was in counties in which other lands had previously been classified.

Munger gave a paper on "Sustained Yield and Taxation" before the Washington State Forestry Conference in March.

Southern

The data collected in Craig's tax index project in Mississippi has been analyzed and indexes computed during the bi-monthly period. A progress report covering five counties (Alcorn, Holmes, Marion, Newton, and Quitman) will be issued early in April ("Taxes on forest property in five selected counties in Mississippi, 1936-1939," Southern Forest Experiment Station Occasional Paper No. 89.)

This report presents data on the average assessed value and average tax per acre, with annual indexes, on forest land classified by forest type and condition-class for each of the five counties separately and for the same counties as a unit. The index-base used is the period 1936-1938 as 100. Taxes included are all ad valorem property taxes levied for State, county, school, and road purposes; excluded are levee and drainage district taxes. A map of the State showing general location of all levee and drainage districts is included, however, with a statement of the State-wide range in, and average of, such taxes for each of the four years included in the period of study.

Field work will be resumed in George and Webster Counties, Mississippi, early in April. Data will be collected for the same period of reference (1936-1939, inclusive) in each county.

Following completion of work in Mississippi, Craig will begin the study in seven counties of Alabama (Blount, Butler, Chilton, Colbert, Jackson, Russell, and Washington), collecting data only on taxes levied in 1939 and payable in 1940.

NEW PUBLIC DOMAIN

Pacific Northwest

Report writing consumed most of the time of this bimonthly period. Cooperation continued in land economic inventories and land use planning with Washington State College, BAE, etc. A check-up of Oregon counties showed that some were catching up with the property tax foreclosures, many were still far behind, and all were planning foreclosures in the year 1940 with the aid of the State Tax Commission. Oregon laws of 1939 contemplate annual foreclosures of all foreclosable lands in each county. In the past, foreclosures have been held irregularly and have not included all foreclosable lands. In some counties they might occur once in 5 or more years. In others, they might include all lands delinquent 10 years and more, whereas all lands delinquent 3 years and more might be foreclosable. The 1939 change resulted from a realization that delayed action favored delinquency, added to foreclosables, and actually increased county expenses. It took a long time to develop an acceptable attack on this rather easily understandable phase of the costs of tax delinquency.

PRIVATE FORESTRY

Allegheny

Anthracite Survey. Based on information given Ritter by local men, and checked on the ground by him, his report on intensification of the Pennsylvania State system of protection against fires recommended 32 physical improvements, requiring 108,000 man-days of labor, in the Wyoming Valley alone. Nearly 2,650,000 man-days of labor could probably be absorbed in constructing similar needed improvements in the anthracite region as a whole. These include foot trails, truck trails, fire hazard reduction, water development, and similar standard improvements very badly needed in a part of the State which has only 15 per cent of the forest land, but 30 per cent of the annual burn.

Our search of Luzerne County records has revealed about 40 tracts which the county "bid in" following a tax sale in 1912, and which presumably have since remained in county ownership. Although this list has been steadily whittled down by a careful follow-up of the records for each tract, we still expect to show that the county

owns several hundred acres, suitable for community forests of one kind or another. At the first tax sale held in Luzerne County since 1912, seated lands tax-delinquent in 1929-30 were nearly all taken over by the county, but may be redeemed by the owner at any time during the next two years.

The land ownership map for Luzerne County, on which we expect to indicate individual properties of 300 acres or more, is progressing satisfactorily, and is proving immediately useful. Among most local land-owners, we find an encouraging interest in the Survey and its objectives.

Lake States

Farm Forestry. Norris-Doxey research projects are already well under way in Michigan, Wisconsin, and Minnesota.

The Michigan project centering at the SCS demonstration project near Flint is aimed primarily at finding profitable outlets for the kind of forest material which can be removed under good forest practice--in other words, a market survey. Carl Holcomb, formerly on farm-forestry work at St. Paul, is working on this project out of the Michigan State College. He is being assisted by Harold E. Peterson on temporary detail from Region 9 and by John W. Strahan who is employed by the college.

The Wisconsin project deals with comparative returns from grazing and forestry on different types of land and with different kinds of treatment. The forestry phase is being started by Kenneth Pomeroy on detail from the Manistee National Forest. The Station representative is Robert A. Farrington. Forest Products Laboratory participation is expected at a later date. Pasture phases are being directed by professors of Animal Husbandry, Agronomy, and Soils at the University of Wisconsin. The work is being started at Richland Center in the southwestern part of the state.

In Minnesota, the farm-forest research project will be concentrated on the problem of how to use more home-grown timber on the farm--particularly for farm buildings, corn cribs, and the like. Preliminary surveys will be followed by experiments and demonstrations in southeastern Minnesota. Charles White is project leader and is being assisted temporarily by Darold F. Newville on detail from the Chippewa National Forest.

H. C. Moser is supervising the Lake States Norris-Doxey projects out of the St. Paul office.

Northeastern

Farm Forestry - Connecticut. Observations have been made on an 80 h.p. boiler at the Niantic State Farm for Women while operating with coal as fuel. These tests are to be used as the basis for comparison when suitable arrangements can be made for the burning of hogged wood under the same boiler. During these tests an experiment by the state was tried at another state institution in the feeding of stick wood (4 ft.) through the side of the boiler with a mechanical hoist. The disappointing results of this method of firing so far obtained would indicate that the feeding of wood in a hogged form would be more feasible, and is supported by the results obtained commercially in this section by wood using industries. Financial limitations at the present time have made necessary temporary suspension of this phase of the Farm Forestry program.

Periodic observations of 10 charwood heaters owned by residents of Connecticut are being made to determine the value of these heaters for homes and small buildings. Mechanical failure of the plates in these stoves seems to have been corrected by a new design which reinforces the plates by ribs. The stoves have been found to operate satisfactorily with green wood and appear to be the answer to a long-felt need for a stove which produces an even heat with a minimum of attention.

Final plans and record forms for time studies of fuel wood production using tools and equipment of new designs were prepared. An area on the Cockaponset State Forest was selected for the operations and some of the timber has been marked for cutting.

Investigations were opened on the possibility of using wood for the production of producer gas. Estimates submitted by the manufacturer of producer gas equipment have been checked and although the estimates made by the manufacturer indicated a very optomistic outlook for this outlet for lower grade hardwoods, nothing in the way of recommendations of installation of equipment will be made until more information is available.

Preliminary investigation has indicated that a single flow Swedish type of charcoal kiln holds the greatest possibility for study and adoption to the production of portable kilns. This type of kiln requires a minimum of attendance and can be used with small charges of wood. Its shape can be varied and it produces a quality of coal suitable for needs in Connecticut. The design of an experimental kiln has been prepared and actual test will soon be under way.

RANGE ECONOMICS

Intermountain

"White collar" WPA projects in range economics studies. The Range Economics Division of the Intermountain Forest & Range Experiment Station instituted work as a part of an experiment station "white collar" WPA project in June 1939 for the purpose of compiling data on the public range resources and range use in the Intermountain region. The objectives of this work were: (1) to compile and summarize data on the present grazing use of the national forest ranges and the private and Federal grazing district lands used by these permittees; (2) to compile and summarize the present licensed grazing use of the Federal grazing districts. The intimate relationship between the two kinds of public ranges and the privately owned lands in this region indicated a need for a knowledge of the use relationships of these lands in planning for the grazing use of the national forests.

Three sets of basic data were used: (1) the 1937 commensurate property study reports of the various national forests made by the Division of Range Management R-4; (2) the 1939 letters of transmittal of national forest grazing permits; (3) the 1939-40 grazing licenses issued by the U. S. Grazing Service. The latter were secured from the regional offices and transferred to mimeographed forms designed for this purpose. This work was done by clerical help hired in the field.

The compilation of these data was broken down into a series of steps, each step involving only one simple task at a time so that the WPA worker could easily understand the job required of him. It was found early in the project that each man's work had to be checked by another worker so as to insure accuracy. Some difficulty was encountered in getting men adapted to this type of work and some revisions of procedure were required. Generally, men with bookkeeping or similar training proved to be the best. This station was fortunate in securing a good project supervisor. Some of the workers have become very accomplished in the use of calculating and adding machines. These men have been used to do the summarizing and calculating and the less able workers the job of sorting into enterprise size classes and compilation.

Without the aid of this WPA project the Range Economics Division would have been unable to develop the basic data on public range resources and range use it now possesses. The results of this project are now being studied and will be presented in a series of reports entitled A Graphic Summary of Grazing on the Public Lands of the Intermountain Region. Part 1 of this series has just been put out

and Parts II and III will be forthcoming in the near future. Range Economics Division of the Intermountain Forest & Range Experiment Station believe that with proper supervision and careful planning of the procedure "white collar" WPA projects are valuable in the compilation and summarization of large amounts of data.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Appalachian

Fire Danger. Jemison met with Stickel of the Northeastern Station and members of the NEFE organization in Boston early in February to study the past year's fire danger records and plan for continuing danger measurement during the coming season. Analyses showed the system to be checking very well against fire occurrence and behavior records. Many useful facts have resulted from the detailed study of fire-weather records and fire reports. For example, 38 percent of 604 debris-burner fires in one portion of New England occurred on class 4 and 5 days (the two highest classes) although such days occurred only 7 percent of the time.

A detailed check of the new coastal plain danger meter is being made against fire records on state lands in North and South Carolina. Jemison and Keetch spent the last week in March in the field gathering data for this analysis.

Fire Damage. A satisfactory method for evaluating fire damage attributable to mortality and cull has been worked out. Keetch and Warlick are completing a field survey of recent burns which will permit the most reliable determination of tangible damage ever obtained for this region. With this part of the problem solved, the job of appraising intangible damage can be logically undertaken.

California

In connection with final preparation for publication of the manuscript, "Visibility of a smoke column," Bruce has prepared a detailed analysis of Byram's "Physical factors affecting the visibility of small smoke columns," published in Monthly Weather Review, August 1936. The primary purpose of the review is to

explain Byram's article for the benefit of those less familiar with visibility theory in terms of the basic relationships which led the author to the conclusions presented.

On the firebreak about the grounds of the Institute of Forest Genetics at Placerville, a 5-foot backfiring lane has been sterilized with white arsenic. Approximately 10 pounds per square rod were spread. This rate of application is higher than that normally used, but was required by the particular heavy red soil prevailing at the Institute. It is expected that this treated lane will remain sterile to annual vegetation for nearly ten years. Full width sterilization of the firebreaks in Region 5 is not recommended because of the added cost and the generally accelerated erosion of the resulting bare soil.

Buck and Abell attended the Ogden Fire Control meeting of February 26 to March 4. Of particular interest to this Station was the insistent demand for extension on a much broader scale than heretofore of behavior studies similar to the type conducted at the Mount Shasta Branch Station. Studies having direct and immediate application in the development of local and national fire danger rating methods and systems received the principal emphasis.

Lake States

Danger Rating. The last of February and first of March, Mitchell attended the conference of fire control administrative and research men in Ogden. Following this meeting he participated in a conference of state fire control executives in Milwaukee at which he discussed the rating of fire danger and the application and limitations of such ratings. Ralph Dickie, who has been helping compile the 1939 fire weather reports, completed his detail and returned to the Upper Michigan on March 2.

February and March have been largely devoted to analyzing the 1939 fire weather records and in preparing a summary of available fire danger records for the Regional office. While sufficient data are not yet available to establish normal conditions, computations, based on three years of records for the Central States and four years for the Lake States, have been made. These show by forests and for the Central and Lake States as a whole, the average danger prevailing, by units, months, and seasons, and the average number of days in each danger class.

A graphic summary of the dates on which vegetative conditions change, as reported by ranger districts, was also prepared.

A study of the relation of danger ratings to the occurrence and behavior of fires has developed the fact that while differences in the risk of fire occurrence and in fuel types between units call for local differences in organization and action intensities, the rate of increase in number of fires and area burned is directly correlated with the danger ratings. As a result, the seven danger ratings used in Region 9 have been tentatively weighted 1, 2, 4, 8, 16, 32, and 64. Multiplying the number of days in each danger class by these weights and dividing the total by 64 times the number of days involved makes it possible to compare units and periods as to relative danger in terms of the percent of the worst possible or theoretical maximum. While the weights called for by other danger meters would doubtless differ, the method offers a means of correlating danger ratings generally.

Based on the thesis that total risk or fire load is a function of relative danger, risk of fire occurrence, risk of spreading, and area protected, a tentative formula has been developed for rating total risk by units which provides a basis for judging relative fire control needs. This formula was presented and explained by Mitchell at a Station seminar held February 15 and created considerable interest.

Northeastern

Fire Danger Measurement. Early in February Stickel met with Jemison in Boston to assist in the development of plans for continuing the fire danger measurement work that the New England Forest Emergency Project has been carrying on in New England and on Long Island. No changes will be made in either the danger meter or danger classes used last year. However, by a relocation of certain of the danger stations, it is expected that a better representation between fully timbered and fully exposed as well as intermediate sites will be obtained. A new coding schedule was also devised preparatory to the analysis of the 1940 fire and weather records.

Fire Detection. The analysis of lookout detection needs in the hurricane area in Massachusetts which is being made by the New England Forest Emergency Project under the technical advice of the Station, got underway during the middle of February. The seen-area mapping work by the profile plotting method is being done by a staff of four CCC boys all of whom are forest school graduates and who have been detailed to the Athol office of the Project.

Fire Damage. Stickel completed a progress report on the basal-wounding plots which has been distributed to the state foresters in the region and to the eastern forest experiment

stations. The data from these plots clearly demonstrate that basal-wounding by fire is of serious consequence particularly as far as the merchantable portion of the stand is concerned. A summary of the average post-fire conditions of these stands is contained in the following table.

	NORTHEASTERN OAK 6 yrs. after Burning		NORTHEASTERN WHITE PINE 3 yrs. after Burning		NORTHERN FOREST 1/ 6 yrs. after Burning	
	Number	Percent	Number	Percent	Number	Percent
STAND BEFORE FIRE, per acre	1213	100	1344	100		
STAND AFTER FIRE, per acre						
Trees Killed	783 2/	65	946 2/	70		
Trees Alive, Uninjured	53	4	4	1		
Trees Alive, Injured	377	31	394	29		
DEVELOPMENT ON INJURED TREES						
Died	115	31	124	32	30	52
Attacked by Fungi	91	24	12	3	5	9
Attacked by Insects	4	1	54	14	4	7
Attacked by Both Insects and Fungi	20	5	12	3	8	13
Open Fire Scar Only	41	11	48	12	5	9
No Open Fire Scar	106	28	144	36	6	10

1/ The data for the Northern Forest region are not on an area basis; all trees observed on the three plots had been injured by fire.

2/ Almost 60 percent of the immediately-killed trees were 2 inches D.B.H. or less in size.

Northern Rocky Mountain

Duff hygrometers, the original instrumental method of measuring fuel moisture, are to be discontinued in general field use in Region One in 1940. Although these instruments have been used at several stations in this region since 1924, and while they measure one factor of fire danger not included by any other technique, the fact that comparability of danger ratings is weakened by their use is one reason for discontinuance.

Experience of the past few years has shown that at present fire danger ratings must be primarily comparable from station to station and year to year even though they are merely abstractly typical. To be concrete or absolutely indicative of fire behavior the factor

measurements would have to sample each of all the fuels and each of all the weather and topographic factors for all significantly different spots within a ranger district. The rating for each station would then have to be weighted according to the area having exactly similar fuels, weather, and topography before it could be combined with ratings from other stations to obtain a single rating for a large district or forest. Such refinement is as yet economically unjustifiable, of course.

By selecting only the most essential factors of danger such as fuel moisture and wind, and by selecting one generally typical fuel and one generally typical level above ground at which to measure wind, it has been possible to obtain an abstract or qualitative index that has been found useful. Critics have carped at the omission of vegetation condition; friends have complained that specific fires - perhaps in cheatgrass or in a mess of old windfalls and snags - did not behave exactly as the index indicated, and they have all been correct, of course. At first it was unthinkable and it is still impossible, however, to measure each of the many sizes of all the numerous kinds of fuel that contribute to the spread of every individual forest fire under all possible combinations of fuel, topography, and weather in this region.

But the measurements of a typical fuel and of air movement at a typical level do furnish a more specific criterion of fire danger than the old reports that "she's getting dry here," "pretty bad" there, and "critical" somewhere else. Most of us still see only what we want to see, and if we liked to have lots of men working for us it used to be altogether too easy to generate a little higher fire danger, merely by saying so.

To use measurements as a check on these human tendencies it was and is absolutely essential that all the measurements be made exactly alike. Duff hygrometers offered the first method of measuring one reasonably typical fuel in the same way at all stations. When further research showed that small sticks not lying on the ground responded to the weather quite differently from duff on the ground we added small sticks. At some stations we averaged the top duff moisture and the half-inch stick moistures to get a more "typical" fuel moisture. At others we used duff moisture alone. As new stations were installed, especially in the old burn fuel types, field men generally chose the sticks alone as being more typical than duff moisture.

In the meantime our measuring stations were so few and far apart that a little difference between duff moisture at one station and stick moisture at another could not be detected, and actually made no difference. Location of the station and the spot at

which the instruments were exposed were often far more important. Furthermore, nobody knew just how much harder a fire burned at 4 percent than at 6 percent. Consequently, the reports from numerous stations were as comparable as they needed to be.

With more stations, more experience, and a man's hide sometimes hanging on a fuel moisture measurement, small and minor differences between stations and days began to stand out, or, rather, to be stood up. Field men began to detect instrumental errors that were meaningless a few years earlier. Other measurements were being made that could be used as a check, and comparability of danger ratings between stations became a common subject of cussion and discussion.

Even at Priest River, the nursery of the first crude duff hygrometers, it took us 15 years and the use of several $300 recording instruments to appreciate fully that duff hygrometers are hard to calibrate and harder to hold in calibration. We hung on to the job, hoping that we could discover or invent methods of calibration and checking that would guarantee accuracy and comparability at all field stations. Our fall check, last year, however, destroyed the "last vestige of hope." Too many of the hygrometers returned for annual calibration varied too much from the median instrument, and nearly all of them registered too far above the true duff moisture content. We had to admit that by their use we were weakening the all esential comparability.

But this is no obituary. By constant checking and properly applied "wet towel" treatments research men can keep those female rattans within the bounds of accuracy. We are going to continue to use them in our research work to account for one factor which varies sufficiently from half-inch wood moisture to produce significantly different ratings, especially during critical seasons. Eventually, it may be possible to devote a research project to the accurate measurement of duff moisture. That need is fully equal to the necessity of measuring vegetative condition. Both are aimed at making the danger ratings less abstract and more concrete, specific, typical.

This same fundamental need for comparability first, and spot accuracy second, is basic also to our wind measurements. In this region it is not believed to be essential that the instrumental accuracy be greater than the error of sampling. So long as differences of 5 percent in the wind velocity can be found when several accurate anemometers are exposed side by side, all at the same level above ground, there is little point to the purchase of expensive anemometers in order to obtain greater accuracy than 5 percent. And so long as wind tunnel experts insist that air movements of less than 3 m.p.h. are difficult to determine accurately even in a wind tunnel with a steady air movement, there is little point to our demanding anemometers with starting speeds below 3 m.p.h.

Low starting speeds require high sensitivity, greater precision of manufacture, and much greater cost. To insist on such sensitivity and then use the instruments in the field where the air movement on a knoll 10 feet higher and only 100 feet away, or in a depression 10 feet lower and therefore experiencing 50 percent more or less wind (1 or 3 m.p.h. as against 2 at the instrument) would appear to be paying too much for useless and nonexistent precision. If the measurement is made 10 feet above the ground that is not the velocity at the ground surface spreading a grass fire, nor is it the velocity actually fanning a slash fire 2, 3, or 4 feet above the ground.

The need, and the only present justification in this region, is for typical wind measurements, made alike at all stations, and therefore comparable between stations, from day to day, and year to year. We are not yet able to or justified in measuring all the wind levels that affect every spot and every fire in this region.

Pacific Northwest

New Burning Index Table Prepared for Use in Region 6. In response to a demand from the national forests of Washington and Oregon for a basic table which would show the wide range in fire behavior resulting from various combinations of fuel moisture and wind velocity, Morris reviewed all existing sources of information and prepared a new burning index table on a scale of 1 to 100. Although it was originally intended to develop a burning index scale of 1 to 10, the 1 to 100 scale was finally adopted because all the experimental evidence and actual experience as recorded in the fire reports indicate that the fastest spreading fires in this region spread at least 100 times faster than the slowest fires. Therefore the 100-unit scale is required in order to show the true magnitude of the differences in fire behavior that are due to fuel moisture and wind conditions.

In the following table the values indicate the effect of weather factors on the start and spread of fires when all other factors are at a constant level, but obviously do not allow for differences in kind of fuel and slope.

Wind velocity	Fuel moisture indicator stick - percent									
	3	4	5	6	7	8	9	10	11-15	16-25
0-3	19	15	11	8	5	3	1	1	1	1
3.1-6	27	21	18	13	9	6	3	2	2	1
6.1-9	35	30	25	19	15	10	6	3	2	1
9.1-12	48	40	34	28	23	16	11	6	3	1
12.1-15	61	53	45	38	32	25	19	14	5	2
15.1-18	75	66	57	49	42	33	27	20	8	2
18.1-27	100	90	77	67	57	45	38	28	11	4

(For fuel moisture indicator stick values over 25 percent the burning index is 0.)

In order to facilitate the use of this new table in making strength-of-force plans, the 100 units may be divided into 10 groups. For many other uses (for example, to indicate the burning conditions on the fire reports or for use in dispatching) the tabular values can be used without any such grouping.

The table was made to meet the following specifications:

1. The burning-index values should indicate the true numerical effect of weather factors on the start and spread of fire. Thus all other factors, such as number of fire brands (risk); kind, quantity, condition, and distribution of fuels; topography; etc., do not enter into the burning-index values; i.e., the burning-index values express the basic physical relationship of weather factors (principally wind and fuel moisture content) to fire behavior under an assumed constant level of all other factors.

2. For the assumed conditions the table should give universal physical relationships applicable to Oregon, California, or Maine. It is desirable to be able to use the same table along the coast and in the interior. If local fuel, topographic, or other differences can be recognized they should be considered as a necessary local correction factor to be used in applying the burning-index table.

3. The table scale should be linear; i.e., the steps in the scale should be approximately equal throughout the scale. For example, the difference in fire behavior between 3 and 4 should be the same as between 50 and 51.

4. The lowest appreciable danger of fires igniting and spreading should mark the boundary between 0 and the first positive value and the highest danger expressed should be the highest likely to occur, but it should be possible to express still higher values in the same scale if they should occur. The entire scale of fuel moistures and wind velocities that have an appreciable effect on fire behavior and which actually occur often enough to be important should be included.

5. The table will be made for the dead herbaceous condition.

6. Policy, safety factors, or psychology should not be included in the table. These should be reserved for the application phases. The table should show only the basic physical relationships.

The table was based on the California data represented in their April 20, 1939, danger meter; the ratings were obtained by multiplying the California ignition index values by their spread index. This gives the probable relative amount of fire perimeter to be controlled under different fuel-moisture and wind conditions if any given number of fire brands are applied to the fuel. These values were then adjusted to make 100 the highest value in the table. (The amount of the adjustment is shown by the fact that this highest value before adjustment was 73.) The process was entirely mechanical without any judgment or bias entering into the result.

The new table will be given experimental application on several forests during the 1940 season before it is finally put into general use.

Southern

Effects

The controlled burning on the Palustris Experimental Forest was done in February. This is a study to evaluate the use of fire in managing a stand of longleaf pine seedlings from germination to the establishment of normal active height growth. The seedlings are from the 1935 seed crop; the first burns were made in January 1937 and some burning has been done every winter since then. The burns this winter were particularly important because the brown-spot needle disease, Lecanosticta acicola, has reached epidemic proportions in parts of the area studied and because a considerable amount of new height growth is anticipated during 1940. It was, therefore, necessary to burn all areas where the schedule of burning was left to the judgment of those currently administering the study. These, in addition to those regularly scheduled, made the amount of burning (14 of 32 compartments and about 500 of 1200 acres) greater than it has been previously or is apt to be in the future.

Behavior

Additional data in rate of spread in the shortleaf-loblolly pine-hardwood type have been taken from test fires set on the National Forests in Texas and Mississippi and near Crossett, Arkansas. It is hoped that these data will strengthen the data that have been accumulated already, to the point that an equation or formula for

describing fire behavior in this type can be deduced.

FOREST GENETICS

California

Physiology. Experimental data on growth hormone distribution in ponderosa pine seedlings and transplants, accumulated during the past two years, have been analyzed, and a report is now being prepared. A brief summary of the findings follows.

In a leading shoot of ponderosa pine transplants very little growth hormone is found at the tip. Hormone concentration gradually increases from the tip to the base of the shoot, and most of the hormone was detected just above the first whorl. Xylem contains more growth hormone than phloem. Very little growth hormone was found in the needles.

Our findings are entirely different from the results reported by previous investigators working with angiosperms. It appears that the anatomical peculiarity of a conifer shoot, as compared with a shoot of broadleaf trees, is responsible for the unexpected hormone distribution in the young ponderosa pine trees.

Breeding

Four trees were obtained from a small crossing experiment made in 1933 with pitch and loblolly pines, in which cross pitch pine was the seed-parent. Although the data are very meagre, it may be stated tentatively that at least two of the trees are hybrids because: (1) they are more vigorous, have a better form, and appear to be healthier specimens than the corresponding progeny of the seed-parent species, and (2) their buds tend to resemble the bud of the pollen parent, which is relatively non-resinous. Further study is required, however, to make certain of the heredity of these trees.

A hybrid between those species may prove to be of considerable economic importance because it would enable the forester, assuming that frost-hardiness is intermediate, to utilize the greater vigor of the loblolly pine considerably to the north of the present distribution.

Northeastern

Hybrid Poplar. The preliminary results of experimental work on growth of the Oxford hybrid poplars on sod land, undertaken in 1939, has been presented in Occasional Paper No. 8.

Dormant cuttings of hybrid poplar were planted in sod; circular scalps 6, 12, and 24 inches in diameter; and plowed ground. Survival for all methods of site preparation was sufficiently high to be rated successful in ordinary practice, but the average height growth on sod was 10 inches as compared to 45 inches on plowed ground. The poor growth vigor on sod and on the smaller scalps indicates that hybrid poplar can not be successfully established on grass land without adequate site preparation.

In the light of past experience, it is extremely doubtful whether better results can be expected on grass land from the use of 1-year-old rooted trees instead of dormant cuttings.

Controlled Breeding. The 1940 breeding work is now under way with a limited number of pollinations completed on Acer saccharinum. Hybridization on this species as a female parent has of necessity been limited to cross-pollinations with Acer rubrum.

Vegetative Propagation. Experimental work on methods of propogating white pine (Pinus strobus L.) from greenwood cuttings, conducted during the summer of 1939, has now been summarized. Preliminary examinations of cuttings grown in outdoor propagating beds indicated a considerable difference in percent survival for groups given various physical and chemical treatments.

The fall examination showed that no rooting had occurred after three months in the propagating beds. This bears out previous observations that white pine cuttings require a longer period for rooting than some of the hardwood species. Dormant white pine cuttings planted in the greenhouse in February did not root until July or August, a period of at least six months under the most favorable propagating conditions.

In the outdoor beds practically all the living cuttings were in a vigorous condition at the end of the first season, and their survival percentage may give some index of the possible effectiveness of the various treatments.

Reserve food supply. The amount of reserve food appears to be an important factor in prolonging the life of the cutting until such time as the necessary nutrients can be obtained through newly formed roots. Cuttings which included only the current season's growth did not survive as well as cuttings with a portion of the previous season's wood at the base. The mallet type of cutting was

superior to the commonly used heel type. The fact that the greenwood has not completed growth when the cuttings are taken indicates that a reserve food supply may be an essential requirement for their continued vigorous growth until they are able to survive on their own roots.

Auxin treatment. Chemical treatments included the use of indolebutyric acid, indoleacetic acid, naphthaleneacetic acid, and naphthaleneacetamide both in solution and talc dust. Although with one exception no significant difference in survival was noted for the groups of cuttings given the various auxin treatments, this is not necessarily indicative of how the treatments will ultimately influence rooting. Such comparisons will be possible with greater certainty at the end of the second growing season. Treatment with both solution and talc dust, the exception noted above, gave the poorest survival.

Reduction of leaf area. Many propagators reduce the leaf area of coniferous cuttings either by clipping the needles or removing a portion of the foliage entirely. Several combinations of type and degree of removal were used in these experiments. Greatest survival was noted for those groups of cuttings in which the leaf area was not reduced in any way prior to planting, and mortality increased progressively with an increase in the leaf area removed. It appears that in white pine reduction in leaf area is not only unnecessary but actually increases mortality, possibly through the loss of photosynthetic surface essential for maintaining the cuttings in a living condition.

Cuttings from trees of different ages. Survival at the end of the first growing season was not significantly different for groups of cuttings taken from trees of different ages. Actual rooting ability, however, may vary considerably; this will not be apparent until the end of the second growing season.

Position of the cutting on the tree. A significant difference in survival was noted for cuttings taken from different portions of the tree. The most distal cuttings from the terminal leader, in terms of branch order, showed the greatest percent survival. It remains to be seen whether there is a direct relationship between survival and rooting in these instances.

Pacific Northwest

The plantation of hybrid poplars, established last year on lands of the Crown Willamette Paper Company on Lady Island in the Columbia River, was duplicated this year using only the 17 most promising lots of Oxford Paper Company hybrids. Alternate rows of one-year-old rooted native black cottonwood trees were planted by way of comparison.

Appalachian

Generalized Formula for International Log Rule. During work on a study of converting factors for oak pulpwood it was necessary to obtain precise values for International board foot contents of logs of odd lengths. The following formula, derived to fill this need, may be useful elsewhere. It gives the contents in board feet, International, 1/4 inch kerf for logs of any length.

$$V = .04975LD^2 + (.0062188L^2 - .18538L)D + .00025911L^3 - .011586L^2 + .042198L,$$

where V = volume in board feet International, 1/4 inch kerf.
L = length of log, in feet, and
D = diameter inside bark at small end of log, in inches.

The equation was derived as follows: The fundamental formula for the International Rule as given by Clark (Forestry Quarterly, Vol. 6, p. 86, 1906) is

$$V' = .22D^2 - .71D, \text{ for a log 4 feet long} \qquad (1)$$

where V' = volume in board feet International, 1/8 inch kerf. The volume when the kerf is 1/4 inch is obtained by multiplying (1) by .9048, giving

$$V = .199D^2 - .642D, \text{ for a log 4 feet long.}$$

Now if
t = taper, in inches, of a 4-foot log,

then volume of 8-foot log = $.199\left[D^2 + (D+t)^2\right] - .642\left[D + (D+t)\right]$.

volume of 12-foot log = $.199\left[D^2 + (D+t)^2 + (D+2t)^2\right] - .642\left[D + (D+t) + (D+2t)\right]$,

and volume of log 4n feet long = $.199\left[D^2 + (D+t)^2 + (D+2t)^2 + \ldots + (D + \{n-1\}t)^2\right] - .642\left[D + (D+t) + (D+2t) + \ldots + (D + \{n-1\}t)\right]$ (2)

This reduces to (See Chrystal: Textbook of Algebra, Part 1, p. 484 et seq.)

$$\text{vol. of 4n-ft. log} = .199nD^2 + \left[.199tn(n-1) - .642n\right]D + .199t^2\left[\frac{n(n+1)(2n+1)}{6} - n^2\right] - .642t\left[\frac{n(n-1)}{2}\right] \qquad (3)$$

where n = number of 4-foot sections in a log.

Now if L = length of a log in feet,

$$L = 4n$$

and

$$n = \frac{L}{4} = .25L \qquad (4)$$

Substituting (4) in (3)

$$\text{Vol. of log of length L, } = .04975LD^2 + (.0062188L^2 - .18538L)D + .199t^2\left[.00520833L^3 - .03125L^2 + .04166667L\right] - .642t\left[.03125L^2 - .125L\right] \quad (5)$$

Formula (5) gives contents in board feet, 1/4 inch kerf, for logs of any length, L, and of any taper per 4-foot section, t.

The International Rule uses a taper of 1 inch in 8 feet or .5 inch in 4 feet. Therefore

$$t = .5$$

and (5) becomes the formula first given.

Central States

The editing of the manuscript on growth and yield of plantation black walnut was almost completed. Work on the second manuscript for this species is underway.

In cooperation with the Ohio Woodland Survey, local volume tables were prepared for white ash and for hickory (species combined) from measurements taken in Stark County, Ohio. Reworking of other tree data to provide volume tables reading in d.b.h. and merchantable height to a variable top diameter was initiated. The local volume table for yellow poplar in Stark County, Ohio was prepared for issue as Station Technical Note No. 1.

Discussion with members of the Wayne National Forest has pointed out the need for board foot volume tables which more closely approximate local utilization. Current cutting practice uses an 8-foot 8-inch stick which produces a tie. Effort is being planned to cooperate in providing suitable tables.

Lake States

Sampling Techniques. A study of the application of three different sampling techniques to the problem of forest surveys was completed by Gervorkiantz and Blythe. Each sampling method was applied to four different types of population. A method of sampling based on a systematic scheme giving as uniform coverage as possible with the intensity of sampling being used, was found to give results which consistently agreed with the normal curve of error. On the other hand, random sampling, when applied to highly stratified populations, gave distributions of means and variances which differed significantly from the normal law of error.

Pacific Northwest

Permanent Growth Study Plots in Second-Growth Douglas Fir. The third report on 3 one-acre plots on the Mt. Hood National Forest that was completed last month summarizes a decade of stand history from age 45 to 55 years for typical Douglas fir second-growth on average site. In ten years the total volume increased from 6,500 to 8,000 cubic feet per acre, and from 11,000 to 23,000 board feet, Scribner rule. Growth in board measure was exceptionally high owing to the numerous trees (39 per acre) that grew to the minimum saw timber size of 12 inches during the decade. Obviously this rate of recruitment cannot continue throughout a rotation but is typical of this stage in an even-aged stand's life cycle.

Permanent Growth Study Plots in Virgin Ponderosa Pine. Pringle Falls plots 22 and 23 had their second examination in 1938, six years after establishment. The purpose of the plots is to determine the mortality and growth in virgin stands of ponderosa pine. Their stand structure varies somewhat, there being more mature trees on plot 22 and more immature trees on plot 23. Their respective growth figures are indicated in the following table.

	Plot 22		Plot 23	
	Bd. ft. per acre per year	Percent	Bd. ft. per acre per year	Percent
Annual gross growth	72	.32	58	.48
Annual mortality	6	.03	0	.00
Annual net growth	66	.29	58	.48

The period is undoubtedly too short and the plots too small to give now a dependable rate of mortality, but it is surprising to find such low mortality, especially when it is considered that part of the six years was during an epidemic period of insect losses.

Effect of Increment Boring Douglas Fir. Trees that were bored 10 years ago were dissected last month to determine whether they had been affected adversely. Preliminary examinations have revealed no decay establishment as a result of boring whether the holes were plugged tightly by dowel, loosely with a twig or by the core itself, or left open. Physical damage due to boring is slight and confined quite closely to the bole.

Rocky Mountain

Effect of drought years on survival. An analysis of the influence of wet and dry years on the survival in plantations on the national forests of Colorado revealed that only during decidedly dry or wet years has the precipitation a dominant influence on the survival of plantations during their five-year period of establishment. During years in which either the total annual or the summer precipitation deviates less than 25 percent from normal, the influence of precipitation is overshadowed by other factors. No relationship of practical, or even statistical, significance could be established of survival to precipitation, when all plantations from 1906 to 1937 were classed according to wet, normal (plus to minus 10 percent) and dry years. Drought years of less than 70 percent annual precipitation occur at an average of only once in 11 years.

The following table gives a comparison of average survival in plantations established during general drought and wet years.

Average survival in plantations on national forests of Colorado established during drought or wet years.

Drought years	Summer precipitation in percent of normal	Survival percent after first and fifth summer in field.							
		Ponderosa pine		Douglas fir		Engelmann spruce		All species	
		First	Fifth	First	Fifth	First	Fifth	First	Fifth
1924 & 1934	50-80	34	9	59	22	50	25	48	20
1939	40-60	16		30		7		23	
Wet Yrs. 1921 & 1927	110-160	74	26	80	45	80	47	79	39
1938	110-150	53		45		48		49	

Stand studies. In forestry literature lodgepole pine is referred to as a species that grows in even-aged stands. In collecting data for site index determinations both in nature, virgin, and selectively cut stands it has been found that lodgepole pine not only forms even-aged stands but also grows in many-aged stands. Data representing age counts on 15 dominant trees in virgin stands at each of 29 widely separated localities and on 10 dominants of the reserve stand on each of 104 plots of selectively

cut stands in Colorado and Wyoming disclosed amazing differences in ages of dominants in each locality. For the virgin stands the differences in ages varied from 19 to 184 years for each locality with a mean difference of 106 years. While for the selectively cut plots the differences per plot ranged from 7 to 165 years with a mean difference of 91 years.

Even-aged mature stands have been defined as those in which the differences in the ages of trees do not exceed 40 years. With this definition as a basis it was found that 10 percent of the virgin stands and 33 percent of the selectively cut stands may be classed as even-aged. The remainder of 90 percent of the virgin and 67 percent of the cut-over stands are many-aged with differences in ages ranging from 41 to 184 years. Since the selection cutting undoubtedly removed many trees of the oldest age classes it is probable that the age differences found after cutting do not represent as wide a variation as was present prior to cutting.

Southern

The derivation of the International Log rule (1/8"-Kerf) can be found in a number of Mensuration texts. Although this rule is of the formula type, it can not be stated exactly except for log lengths that are multiples of 4 feet. To simplify the statement of this rule for all log lengths and to standardize interpolation procedure the following equation was derived for the International rule (1/8"-Kerf).

$$\text{Vol.} = 22(X)D^2 + \left[\frac{.22}{2}(X)(X-1) - .71(X)\right] D + \left[\frac{.22}{24}(X)(1-2X)(1-X) - \frac{.71(X)(1-X)}{4}\right]$$

Where

X = Log length divided by 4
D = Diameter in inches of the small end of the log.

In this derivation the board foot volume of a 4 foot section is assumed to be given by the equation

$$\text{Vol.} = .22D^2 - .71D$$

where D is defined above. The taper per 4 foot section was assumed to be 1/2-inch per section. If the saw kerf is 1/4" instead of 1/8" the above equation should be multiplied by .904762.

The Internation rule has been criticized because it overscales some logs (especially small logs). This discrepancy is due undoubtedly to the fact that a taper of 1/2-inch per 4 feet is

excessive. If the basic equation for the volume of a 4' section is assumed to be correct and the taper per section is assumed to be "t", the above equation can be stated in a more general form.

$$\text{Vol.} = .22(X)D^2 + \left[.22(t)(X)(X-1) - .71(X)\right] D + \left[\frac{.22}{6}(t^2)(X)(1-2X)(1-X) - \frac{.71(t)(X)(X-1)}{2}\right]$$

In this form the equation can be readily adapted to the scaling of timber in any locality by simply determining the average taper per 4-foot section.

Southwestern

Predicting Yields. Completion of a second cutting of ponderosa pine in a unit of the Fort Valley Experimental Forest has focused attention on future yields. A cutting cycle of 30 years is contemplated. The remaining stand averages 2,968 board feet per acre for the area as a whole, ranging from 2,211 to 3,967 under three different cutting methods described in the report of October 1, 1939, page 59. Distribution is very uneven; the bulk of the growing stock occurs in densely stocked but widely separated groups. Although the groups are essentially even-aged (140 to 150 years) diameters range from 10 to 28 inches. A few mature trees, over 30 inches d.b.h. are scattered over the area. Reproduction is about 80 percent complete; it varies from 2 to 8 feet tall but is essentially even-aged, nearly all having originated in 1919. Age classes between 30 and 120 years are practically absent. The problem in regulation of cut is to bridge the gap between these classes and still continue to cut at 30-year intervals.

Several methods of yield prediction have been tested: (1) Lexen's growth chart[1/] which correlates gross increment with average diameter and volume of residual stand; (2) an earlier yield table by Lexen which correlates net increment with volume of residual stand, disregarding average diameter; and (3) a percentage method which simply applies the known net increment percent during a given period after the first cut to a corresponding period after the second cut. Methods (1) and (2) were checked by applying them to the stand left by the first cut and

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1/ Growth after cutting in ponderosa pine. Research Note No. 51, Southwestern Forest and Range Experiment Station. Also, Growth following partial cutting in ponderosa pine. Jour. Forestry, 37: 943-46, 1939.

comparing with increment obtained from actual records of growth and mortality. Since the growth chart used in (1) covers only 20 years, comparisons are limited to this period. In this check, method (1) gave a 20-year gross increment of 1,800 board feet per acre, which, after deducting the known mortality of 20 feet per acre per year, is reduced to a net increment of 1,400 feet. Method (2) gives a net increment of 1,700 board feet. The actual increment was 1,820 board feet. Method (3) obviously gives this same figure. As between methods (1) and (2), the latter appears to be the more applicable. Method (3) has the important advantage of being based entirely on the records of this area; one shortcoming is that it does not take into account the well known fact that as residual volume declines increment percent usually rises. This would have the effect of making predictions ultraconservative because the volume at the beginning of the second cutting cycle is less than that at the beginning of the first cycle.

Prediction of yield in 1969 on a plot of 456 acres by methods (2) and (3):

Method (2) Residual volume 1939, 2,968 board feet per acre
Net increment in 30 years, 2,219 board feet
Total volume per acre in 1969 — 5,187 board feet

Method (3) Residual volume in 1939, 2,968 board feet per acre
Mean annual increment past 30 years, 2.3 percent
Net increment next 30 years at 2.3 percent, 2,048 board feet
Total volume per acre in 1969, — 5,016 board feet

Of more immediate interest is the volume in diameters suitable for cutting 30 years from now. It is estimated that the cut at that time will take nearly all trees then 28 inches d.b.h. or over. Assuming an average diameter growth of 4 inches in the next 30 years, this would theoretically include all the timber now above the 23-inch class. Actually, however, some trees will grow only 3 inches while others will grow 6 inches, and therefore cutting to a minimum limit of 28 inches in 1969 would not include all trees now in the 24-inch class, but would include some below this class. In practice, cutting will not adhere to any arbitrary diameter limit, and therefore the present 24-inch class is to be regarded as only an approximate dividing line.

Methods (1) and (2) do not lend themselves to prediction of the increment of a portion of the stand.

Another method consists essentially of advancing the trees in each diameter class into higher classes in accordance with the average diameter growth indicated by records of the past 30 years. A practical

test, however, has raised serious questions as to the reliability of the method. When applied to the 1909 reserve, using known diameter growth and mortality, the calculated increment during 30 years was 12.4 percent below the actual increment. The reason for this discrepancy is not clear; it may arise from the application of average instead of actual diameter growth, since it is known that trees of a given diameter class will grow at widely varying rates.

Method (3) may be applied to that portion of the stand above the 23-inch diameter class during a 30-year period. The total volume 24 inches d.b.h. and over after the second cutting was 1,772 board feet. The increase of volume in these diameter classes from 1909 to 1939 was 139.6 percent of the 1909 volume. This increase, while due mainly to growth, also includes the advance of trees which were below the 24-inch class in 1909. Applying this percentage to the 1939 residual volume, the 30-year increment is 1,772 x 139.6% = 2,474 and the total volume of trees now above 23 inches d.b.h. become 4,246 board feet per acre. A possible source of error lies in the assumption that the advance from lower diameters into the 24-inch class proceeds at the same rate as during the first 30 years, which may or may not be true. There is an element of conservation in the fact that the blackjack groups have on the whole been opened up more than in the first cutting; and the proportion of large yellow pines has decreased. Mistletoe infection has been more drastically eradicated than in the first cut, which should lower the mortality unless the infection increases.

Applying the same method to units representing the three methods of cutting, the following yields for all diameter classes 24 inches and over are predicted for 1969.

Forest Service Cutting. Residual volume 1,306 board feet per acre; increment 139.6 percent; available volume in 1969, 3,129 board feet per acre.

Improvement Selection. Residual volume 1,477 board feet per acre; increment 139.6 percent; available volume 1969, 3,539 board feet per acre.

Salvage Cutting. Residual volume 2,476 board feet per acre; increment 139.6 percent; available volume 1969, 5,932 board feet per acre.

Whether the indicated volumes are actually removed in 1969 depends on many circumstances, both silvicultural and economic. A heavy cutting may be desirable in order to eradicate mistletoe, or to favor pole stands which will then be pressing for space. On the other hand, it may be considered desirable to hold a large portion of the old stand to improve the cut in 1999, assuming

continuance of the 30-year cycle. The salvage cutting unit will undoubtedly call for a heavy removal in 1969. The calculated yields will be reduced by about 10 percent for defect.

Prediction of volumes more than 30 years hence is rather speculative. Nevertheless, on the basis of numbers in diameter classes between 12 and 21 inches, all-three methods of cutting may be expected to yield substantial cuts in 1999 and leave some trees to form the nucleus of a cut 30 years later. The few poles now 5 to 8 inches d.b.h. will be a factor at that time.

NAVAL STORES

Southern

As long ago as 1933 German investigators, and subsequently Russian ones, have applied many different chemical reagents to a freshly chipped streak in order to stimulate gum production. They have reported yield increases from 100 to 250 percent but much of the information is conflicting. There is rather uniform agreement, however, that most acids are effective, although a 25 percent solution of hydrochloric acid produced the greatest consistent responses. They have found it necessary, however, to renew a double streak at each chipping to maintain increased yields over a period of time because of the action of the acid upon the living tissue of the tree.

Anticipating apparent possibilities for chemical treatment in this country a small exploratory test was conducted on longleaf pine on the Olustee Experimental Forest during 1936. A 35 percent solution of hydrochloric acid, the only reagent used, daubed on the streak immediately after chipping, produced yields about 65 percent greater than untreated streaks when the streak height was 1-inch, but only about 15 percent greater when the height was 1/2-inch.

A more detailed study during 1938 in which 5 and 20 percent solutions of (1) sulphuric acid, (2) acetic acid, and (3) washing soda were applied to three streak heights (1/4 inch, 5/8 inch, and 1-inch) on both longleaf and slash pine, showed that 20 percent sulphuric acid was the most effective. When applied to 5/8-inch chipping on slash pine an increased yield of about 60 percent was maintained for the entire season, whereas the same solution applied to longleaf pine produced practically no increase from 5/8-inch streaks and only a 25 percent increase from 1-inch streaks.

REGENERATION

California

Scotch pine provenience test (International Union Forest Research Organizations). The Feather River test of the 17 Scotch pine seed lots was initiated by sowings in the nursery March 20. In the absence of a general working plan for all organizations, as well as detailed descriptions of the seed lots, a local plan is being followed. The seed was sown in four randomized blocks in the nursery. The seeds were equally spaced in drills with a view to obtaining about 100 seedlings to the meter, the drills being spaced about 10 cm. apart. The drills will be thinned to equal numbers, if germination is sufficient. Uniform watering will be attempted.

The comparisons of 1-0 seedlings will be based on length of top as measured from cotyledons to apex of stem and on dry weight of entire seedlings in samples. The samples will have the same mean length or weight as their respective proveniences by proportionate selection from frequency distribution. Transplants will be sampled in the same way. A test field has been prepared to carry comparisons 5 years after outplanting in six randomized blocks, the trees to be spaced 3' x 3' with double rows for complete isolation strips.

Lake States

More about Seed Storage. Germination tests recently completed by Roe indicate that Chinese elm seed has a greater length of life than is usually believed. Seed which was purchased by the Prairie States Forestry Project in May 1936, stored for ten months in sealed drums in a cool place and since that time in a tightly closed can at 41 degrees Fahrenheit, now shows a germination of 67 percent in 19 days. The initial germination of this seed is not known.

Red oak acorns collected in northern Wisconsin in the fall of 1938 and since stored in a sealed jar at 41 degrees Fahrenheit now show a germination of about 45 percent compared with initial viability of 73 percent.

Pacific Northwest

To test a theory advanced by Mr. Moore of the Biological Survey that rodents will not molest seed spots containing only

one or two seeds under conditions where they will molest seed spots with several seeds, a direct seeding experiment involving 15 plots on three separate but neighboring areas has been established. The experimental area was laid out by Munger and Isaac during a three-day visit to the Cascade Head Experimental Forest when the winter's activities were inspected and spring work outlined.

Statistical Analysis, Planted Stock Survival. The last report gave results of a test of Dowax on planted Douglas fir at Wind River. Analysis of the first-season results of the balanced, randomized block experiment at Pringle Falls, testing effect of Dowax treatment and class of ponderosa pine nursery stock upon survival after planting, revealed the following.

1. Application of Dowax solution very significantly contributed to planted stock mortality. Survival of Dowax-treated stock averaged 80 percent, of untreated stock 86 percent.

2. The three-year-old transplant stock proved highly superior to the two-year-old seedling stock in ability to resist the lethal effect of Dowax. Survival of the former averaged 86 percent, the latter 70 percent.

3. Among the three-year-old classes of stock the survival of that simply transplanted at age one year (81 percent) was significantly inferior to that transplanted at age two years (88 percent) and to that transplanted at age one year and root pruned at age two years (88 percent).

Southwestern

Seed Spot Records. The success of seed spot sowings is gaged not by the total number of seedlings that survive but rather by the percentage of spots on which one or more seedlings have become established. Obviously, the establishment of a single seedling per spot is all that is required; in fact, more than one seedling is usually not desirable because subsequent competition among several seedlings in a given spot may retard growth or even result in the death of all of them.

Frequently reports on seed spot sowings show the percentage of spots containing one or more live seedlings at the end of the first growing season. If all of these spots have several seedlings per spot, the results may be fairly indicative of ultimate survival in that it is logical to expect that where several seedlings per spot are present at the end of the first growing season at least one of these seedlings should survive. Citing the average number of seedlings per spot does not help matters much in that this average may be based on too wide a range. A better way is to show the per-

centage of spots containing seedlings of and above different numbers, such as one or more, two or more, etc. The merit of this method lies in the fact that it provides several bases for estimating ultimate survival. Thus, one may use the percentage values for spots containing three or more seedlings.

In order to illustrate how this method of estimation works, the results obtained in an experiment to determine the influence of soil preparation and spot protection in the sowing of Douglas fir seed are cited. Table 1 shows the percentage of spots containing different numbers of seedlings on different dates.

Comparison of the results shows that although the percentage of spots containing different numbers of seedlings has decreased with time, the greatest decrease occurred during the dry period between the spring of the second season and the advent of the ensuing rainy season. It should be noted that the decrease subsequent to this time was comparatively small.

Comparing now the results of the first examination with those of the last examination for screened spots, it will be noted that the percentage of spots containing 4+ seedlings in August 1938 agrees quite closely with those containing 1+ seedlings in October 1939.

Assuming that the percentage of spots containing 1+ seedlings in October 1939 is indicative of ultimate survival, it is evident that as a basis for predicting survival from the August 1938 data, using the percentage of spots containing as many as 3+ seedlings per spot would still not have been correct. On the other hand, the percentage values for 3+ seedlings per spot in May 1939 would have been about right for the screened spots and 2+ seedlings for the unprotected spots.

To be conservative, it may be assumed that the percentage values for 2+ seedlings, as of October 1939, should be used to estimate ultimate survival. If so, then even the values for 5+ seedlings shown for the August 1938 examination would, on the whole, have been too high, whereas those for 4+ and 5+ seedlings per spot in May 1939 are more nearly correct.

It is, of course, logical that the longer the period between sowing and examination becomes, the more nearly should one be able to estimate what the percentage of successful spots is likely to be. What this discussion has aimed to point out is the need of caution in using early seedling counts as a basis for estimating ultimate survival.

Table 1. Survival of Douglas-fir from seed sowed in fall of 1937 in screened and unprotected and in prepared and unprepared spots. (100 spots sowed under each condition.)

Seedlings per spot	Screened spots		Unprotected spots	
	Prepared	Unprepared	Prepared	Unprepared
	%	%	%	%
	Survival as of August 26, 1938			
1+	91	90	56	57
2+	82	73	29	33
3+	72	58	15	16
4+	61	45	9	8
5+	56	31	5	4
	Survival as of May 7, 1939			
1+	86	77	37	28
2+	75	57	14	17
3+	64	46	9	9
4+	53	37	5	2
5+	42	21	1	2
	Survival as of July 12, 1939			
1+	64	51	15	22
2+	44	33	5	9
3+	31	24	1	3
4+	23	17	0	2
5+	17	9	0	2
	Survival as of October 10, 1939			
1+	61	48	13	21
2+	43	31	4	7
3+	31	21	1	3
4+	22	16	0	2
5+	17	9	0	2

Washington Office

Installation of the mechanical seed counter in the seed laboratory of the Kansas State College Department of Agronomy has greatly simplified the task of testing the germination of 1,200 to 1,400 seed samples a year, according to J. W. Zahnley, associate professor of agronomy.

As these seed samples are each run four times, there are approximately 5,000 tests run on germination a year.

In the operation of the machine, a handful of seed is poured over a metal plate having 100 openings, too small for seed to pass thru. Seed is drawn against these holes, which are spaced an equal distance apart, and excess seed is shaken off.

An electrically-operated pulmotor provides the vacuum for drawing the seeds into the openings. Seeds are dropped on testing blotters by releasing the vacuum. This method replaces the tedious former method of hand picking and counting seeds. Other advantages of the mechanical seed counter are that it is accurate in counting 100 seeds and saves time as the hundred seeds are counted at once. The seeds are placed an equal distance apart on the blotter avoiding contact between the seeds and reducing mold. With this even spacing the roots do not tangle. This makes the germination count much easier.

SILVICULTURE

Alleghany

Stand Improvement

Descriptions of CCC work programs dealing with the establishment and maintenance of T.S.I. demonstrations in New Jersey for 1940 were written. Included are maintenace of the controlled burning and pine conversion plots, completion and maintenance of plots testing the effectiveness of mechanical seedbed treatments in securing pine reproduction, general maintenance and improvements on the Lebanon Experimental Forest.

Silvics

Following a critical re-reading of the manuscript proposed as a Departmental Bulletin on the forests of the northern

Allegheny Plateau, a revised draft is being prepared. Analyses of additional plot data as second growth stands and of the 7-year weather record at the Kane Experimental Forest were begun.

Phenological records from 1937 to 1939 at the Lebanon Experimental Forest were analyzed and a progress report prepared. Seed dispersal of pines and southern white cedar were also reported.

Central States

Tree Defect Studies. The Ohio Woodland Survey, conducted by the Ohio Division of Forestry under a WPA grant, has undertaken a cull and defect study to determine the principal causes and volume losses sustained through mismanagement of farmwoods in Ohio. Field crews have been trained to collect data according to procedure used in similar studies elsewhere in the Central States.

Provisions are being made to extend the regional studies of tree defect into National Forest areas of Ohio and Indiana during the coming field season, with the Civilian Conservation Corps providing men and the Central States Forest Experiment Station technical advice.

Intermountain

Regeneration Factors - Ponderosa pine. The first year results of a study of the role of plant competition in natural reproduction of ponderosa pine were described in the February 1940 Bi-Monthly Report, page 36. Relationship of condition factors to mortality of pine seedlings during the second growing season are summarized here.

As in the first year, the greatest differences were between vegetated and bare plots: mortality from all causes averaged 59.6 percent on vegetated plots as compared to 14.8 percent on bared and trenched plots.

The cause of greatest mortality was drought, which killed 32.5 percent of the seedlings. Rodents caused a loss of 14.7 percent; insects 11.1 percent; heat 5.7 percent; fungi 2 percent; others and unknown agencies 7.4 percent. The order of losses for vegetated plots alone is the same as above, except for greater losses by insects than rodents. Bared plots suffered greatest losses from rodents, followed in order by insects, miscellaneous and unknown, drought, heat, and fungi (no loss).

Losses from drought amounted to 31.9 percent on vegetated plots and 0.6 percent on bared plots. Mortality losses for the three types on vegetated plots were: grass 56.1 percent, ninebark 25.9 percent, and ceanothus 14.8 percent. These differences by types were significant only for north slope plots. Drought loss averaged 36.2 percent on south exposures, compared to 27.2 percent on north exposures, but this difference was not significant. Differences associated with overhead shade were small and of no significance.

Heat caused losses of 5.6 percent on vegetated plots, and 0.1 percent on bared plots. Mortality percentages for the three types on vegetated plots were: grass 10.4 percent; ninebark 4.7 percent; and ceanothus 1.7 percent. Heat kill was eight times greater on south than north exposures while it was three times greater on open than shaded plots. Differences by type, shade, and exposure were significant on vegetated plots.

In contrast to the first year, when fungi was the major cause of loss, this factor accounted for a mortality of only 2.0 percent on vegetated plots and none on bared plots in the second year. Mortality as a result of insect damage was 8.6 percent on vegetated plots and 2.5 percent on bared plots. Rodents (rabbits, moles, and squirrels) caused losses of 5.9 percent on vegetated plots and 8.8 percent on bared plots. Unclassified and unknown losses amounted to 5.6 percent on vegetated plots and 1.6 percent on bared plots. No important relationships to treatment, type, shade, or exposure were found for these biotic and miscellaneous causes.

The experiment indicates that competition from other vegetation is one of the most important factors influencing the second year survival of ponderosa pine seedlings. The difference between survival under competition and without it was greater than in the first year and would have been even more marked if it had not been for severe damage by rodents to the succulent seedlings on the bared plots. Predominating causes of mortality change as the seedling grows older and vary according to environmental conditions.

The heavier rate of loss in the second than in the first year is contrary to usual results and is due to the unusually favorable soil moisture conditions in 1938 as contrasted with the severe drought of 1939.

As in the first year, it was demonstrated that the shade of a living overwood does not materially aid in the survival of seedlings. It does tend to reduce direct heat kill, but this is offset by losses from increased competition and from other causes. This season the grass type showed greatest seedling loss thus reversing its first year standing of least loss of the three types.

Differences in growth and development of seedlings between vegetated and nonvegetated conditions were as striking or more so than the difference in survival. Sample seedling tops were clipped from all plots in June and in October 1939. On the first date only oven-dry weights were determined, on the second date both heights and weights were measured. The average weight of seedling tops on vegetated plots was 0.12 gram as compared to 0.86 gram on bared plots, per the June samplings. In October the corresponding weights were 0.14 gram and 2.37 grams. This is equivalent to a ratio of 1 to 17, compared to a ratio of 1 to 7 in June. The average height of surviving seedlings in October was 2.5 inches on the vegetated plots and 4.8 inches on the bared plots.

On the whole, vegetative type failed to show significant relationships to height and weight of seedlings. In June the seedlings in the grass type were heavier than those in ceanothus and ninebark types; in October they were of similar weight but generally shorter than those in the brush types. Overhead shade had an important influence on height and weight of seedlings. On vegetated plots, heights averaged 2.3 inches in the shade and 2.7 inches in the open; corresponding weights were 0.11 gram and 0.18 gram, respectively. On bared plots, heights averaged 4.4 inches in the shade against 5.1 inches in the open; weights were 1.67 grams in the shade and 3.06 grams in the open. These figures are further substantiation of the fact that ponderosa pine thrives best under full or nearly full light in this locality. They further show, however, that with freedom from root competition, moderate shade does not prevent at least fairly rapid development of seedlings. It was rather surprising that there was very little difference in development of seedlings on north and south exposures. Only in the series of vegetated unshaded plots was the weight of seedlings significantly greater for south than for north exposures.

Lake States

T.S.I. Through Small Sales. In our enthusiasm to put men to work on emergency projects during the depression years, we have often overlooked possibilities of getting stand improvement work done through small timber sales. With a large number of men to keep busy, much stand improvement work has been carried on in stands thought to contain insufficient timber to be salable. Actually they were unmerchantable to the larger operators because the margin of profit was very small. However, Zehngraff has been exploring the possibilities of getting such work done by local woodsmen through small sales on the Pike Bay Experimental Forest. Two adjacent areas of northern hardwoods (with some conifers in mixture) were treated, one by CCC and one by local woodsmen on a sale basis. The stand had twice been cut over, first for white pine, and later for the better hardwoods so that what remained was a stand of cull trees

containing much cordwood and a few logs and ties. The results were as follows:

CCC Job

Labor		$ 1,276.50
Transportation		146.50
Supervision		167.00
	Total	$ 1,590.00
Value of cordwood for camp fuel 300 cords at $2.50		750.00
Net cost of operation (40 acres)		$ 840.00
or $21 per acre		

Timber Sale

Stumpage receipts		$ 201.60
Administrative costs:		
Marking	$ 27.00	
Scaling	17.00	
Supervision	44.00	
Total		88.00
Net income (50 acres)		$ 113.60
or $2.27 per acre		

The CCC did a "prettier" job and some products were left which, however, without the cordwood, can scarcely carry a commercial operation in the near future. The soundness of the investment in such T.S.I. may be open to question. Moreover, from a strictly silvicultural point of view, very little difference could be detected in the two stands remaining. The possibilities of getting stand improvement work done through small operators who are satisfied to make wages (without much profit) seem good on the basis of this test.

Thinning Young Jack Pine. Ten years ago the Station established a series of plots to study the effect of various degrees of thinning on growth and production of merchantable wood in a 20-year-old jack pine stand.

The smaller trees were the ones generally removed. In all, five plots were employed. One of the plots was left unthinned, and the other four were thinned out to 89, 77, 62, and 40 percent of normal basal area, respectively.

A bird's-eye view of the effect of different degrees of thinnings may be obtained from the two accompanying tables.

Table 1. Total basal area per acre before and after thinning

Degree of thinning in percent of normal stocking	Basal area per acre			Percent of normal stocking		
	1929		1939	1929		1939
	Before thinning	After thinning	or 10 years later	Before thinning	After thinning	or 10 years later
Percent	Sq.Ft.	Sq.Ft.	Sq.Ft.	Percent	Percent	Percent
110	110.8	110.8	138.8	110	110	113
89	106.0	66.3	128.6	117	89	106
77	108.7	67.6	121.6	124	77	103
62	102.4	53.6	114.2	119	62	98
40	108.1	36.1	92.7	120	40	78

Table 2. Total cubic-foot volume [1] per acre before and after thinning

Degree of thinning in percent of normal stocking	Volume per acre			Growth during the decade	Total production of wood	Growth percent per year
	1929		1939			
	Cut	Left				
Percent	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu.Ft.	Cu. Ft.	Percent
110	0	1,875	3,515	1,640	1,640	8.7
89	304	1,440	3,233	1,793	2,097	12.4
77	464	1,171	2,996	1,825	2,289	15.6
62	584	948	2,604	1,656	2,240	17.5
40	1,040	649	2,187	1,538	2,578	23.7

1/ Total unpeeled volume.

Northeastern

Hardwood thinnings. A 5-year remeasurement of sample plots established in even-aged 60-year old northern hardwoods on the Bartlett Forest brought out striking differences in the diameter growth of thinned and unthinned stands. The following tabulation based on difference in basal area indicates total growth percents for the various species and size-classes.

Total Growth Percent (5 years) 1/

Species and Treatment	Diameter group 2/ (inches)				Total
	1.5-3.9	4.0-7.9	8.0-11.9	12.0-16.9	
Beech					
Thin	53.7	27.7	21.3	14.1	26.0
Check	22.3	5.1	14.9	7.9	10.7
Yellow Birch					
Thin	19.6	13.0	9.3	-	11.8
Check	-	3.4	5.1	12.5	4.9
Sugar Maple					
Thin	30.0	-	-	-	10.1
Check	14.3	9.2	4.7	-	6.1
Red Maple					
Thin	64.5	13.5	22.6	-	19.9
Check	-	17.3	10.1	-	12.5
Paper Birch					
Thin	-	19.8	15.5	-	15.7
Check	-	14.2	15.0	-	14.8
All Species 3/					
Thin	49.3	14.3	16.9	13.8	18.6
Check	12.2	9.2	8.1	7.5	8.8

1/ Exclusive of trees that died or grew into 1.5" - 3.9" class.
2/ Based on original tally. 3/ Weighted average.

As almost one-half of the original volume was removed on the thinned plot, percentages do not indicate an identical spread between volume growth on the two areas. However, in spite of the reduced residual stand, the increase in basal area of the thinned plot was greater than on the undisturbed check area. There was more new wood on the thinned plot, and as the most promising trees were reserved, this growth was being laid on the better individuals.

If the trees that died over the 5-year period and trees that entered the 1.5" - 3.9" class are included in calculating growth on the two areas, the treated plot shows up to even better advantage. On the thinned area new trees more than offset losses by death, increasing the net growth over the 5-year period to 19.9 percent as compared with 18.6 percent. On the check plot, mortality more than offset the new trees, consequently net growth was reduced to 4.5 percent as compared with 8.8 percent indicated in the tabulation. Net growth amounts to approximately a cord per acre per year, and one-half cord per acre per year on the thinned and unthinned areas respectively.

Pine problem analysis. A Project Problem Analysis was prepared and revised following consultation with the Station staff and other research men in the region. The Analysis showed the need for initiating demonstrations of weeding, thinning, pruning, and various types of harvest cuttings, and filling in certain gaps in the silvics of the white pine types by several basic studies.

In collaboration with Dr. Schreiner, a paper was prepared for the Journal of Forestry on the possibilities of induced flowering in genetics and management of white pine and other types, to obtain reproduction of desired parentage and composition.

Northern Rocky Mountain

Advisory Council Meeting. The Division of Silviculture held an advisory council meeting on the afternoon of March 11. Those in attendance from the experiment station included Bradner, Davis, Gisborne, Greeley, Hurtt, Rapraeger, Winters, Wellner, Peterson, and Bentley. From the regional office were Kelley, Koch, DeJarnette, and Neff. Myrick attended from the Lolo Forest.

Davis summarized silvicultural research since the last advisory council meeting in March 1936 and pointed out major changes in program and presented the present line of attack. He outlined specific plans for 1940 as follows: (1) An analysis of silvicultural research; (2) continuing work in direct seeding; (3) additional field work in early development to round out project;

(4) cooperation with blister rust office in preparing a paper on blister rust in the management of western white pine;
(5) revision and reissuance of stand improvement manual;
(6) preparation of "show-me" material for experimental forests.

Discussion centered around the present program, problems, and plans. Growth and yield problems received a good deal of attention. It was brought out that present information is probably adequate but much of it is not in usuable shape to meet specific management problems. There is something of a pile-up of mensurational work both in silviculture and survey because of shortage of available technical man-power to get out final reports. The need for more and better economic knowledge for the best application of silvicultural methods was stressed. The major problem is not so much one of additional silvicultural knowledge but the economic application of present knowledge. Davis pointed out that much of his work during the past year had been on this phase. The place and value of experimental forests in silvicultural research were discussed. In view of the heterogenity in the forest types of this region and the wide range of cutting practices available for study on the national forests, the group consensus was quite strongly in favor of not centering work too much at these stations but spreading it throughout the types studied.

Ways and means to better working relations between the station and the region received attention. Three means agreed upon were: (1) more frequent discussions of problems, practices, and research results with regional and forest men on the ground in the field; (2) advance review of projects by the station - putting specific questions, problems or projects to the station; (3) getting out more releases and progress reports even though the projects as a whole are far from finished. Partial cuttings in western white pine received considerable discussion. It was brought out that present possibilities for extensive application of partial cuttings on the national forests were limited because of the small acreage of suitable age classes (between 40 and 120 years). It was agreed, however, that partial cuttings had real possibilities and the station should continue study of them. Forestation research came up before the meeting and it was agreed that in view of the good progress made, the station should continue concentrating its efforts on methods of direct seeding to further develop applicable techniques.

Thinnings and improvement cuttings in western white pine. Five-year results from two sets of thinning plots located on the Coeur d'Alene National Forest and the Deception Creek Experimental Forest give an indication of what may be expected from combined low thinnings and improvement cuttings in pole stands of the western white pine type.

One of the sets, including 4 one-fourth acre plots, 2 thinned and 2 untreated as checks, is located in a stand 30 to 40 years of age. Treatment here consisted of an improvement cutting to free western white pine, which in numbers made up two-thirds of the stand, from domination by western larch and Douglas-fir, and a low thinning which removed most of the western hemlock and grand fir trees in addition to the poorer western redcedar and white pine trees in the intermediate and suppressed crown classes. The stand, after thinning, was from 81 to 97 percent pine, with western redcedar and other species making up the remainder. The check plots were marked exactly as if they were to be thinned in order that growth comparisons between thinned and unthinned plots could be made on comparable trees.

The fifth-year remeasurements of this set of plots have shown two major results. (1) Diameter growth at breast height of trees on the thinned plots has averaged one-third again as great for the 5-year period as growth on comparable trees of the untreated plots. (2) Treatment has increased the amount of snow breakage in the upper crown classes. This form of damage occurs on both thinned and unthinned plots but is greater in the upper crown classes of the thinned plots because the trees on these plots are so far apart they cannot assist each other in supporting snow weights as do like trees in the unthinned areas.

The other set of plots consists of 8 quarter-acre plots, 5 thinned and 3 untreated checks, located in a 65- to 70-year-old stand on the Deception Creek Experimental Forest. The stand before thinning averaged 250 square feet of basal area per acre with white pine making up 60 percent of this total and grand fir, Douglas-fir, western hemlock, western larch, and lodgepole pine accounting for the remainder. Favoring white pine throughout, the treatment was mainly a thinning from below removing suppressed, intermediate, and a few codominant trees. Species other than white pine were cut when they dominated pine in the upper crown classes. Treatment of these plots was not as effective as on the first set for white pine largely dominated the stand before treatment.

The thinnings were of two weights. Stocking on three plots was reduced to 150 square feet of basal area per acre, composed mainly of white pine. On the other two thinned plots, stocking was reduced to 100 square feet, almost entirely white pine. Each of the three check plots was marked as if it were to be thinned according to each of the two intensities in order that growth comparisons between thinned and check plots might again be made on comparable trees.

Thinning accelerated the rate of diameter growth on trees of these plots as on trees of the treated plots of the first set. Five-year diameter growth at breast height averaged .47 inch for trees of the three plots reduced to 150 square feet of basal area compared with a growth of .38 inch on comparable trees of the three check plots. The heavy thinnings resulted in even greater increase in diameter growth. Trees on the two plots thinned to 100 square feet of basal area averaged .63 inch of growth during the 5-year period as compared with .44 inch on comparable trees of the check plots.

These increases in diameter were more than offset, however, by losses from snow damage which was increased by treatment on this set of plots also.

Although treatment on both these sets of plots has resulted in an accelerated growth rate on selected crop trees, credits from these thinnings are far outweighed by the debits. The increase in mortality among the selected trees has for the most part outweighed the increases in growth rates. The benefits are far outbalanced also by treatment costs. Little opportunity exists at present to market or even give away material removed in thinning operations in the western white pine type.

Consequently, these intermediate cuttings must be made at a deadweight expense which is so great that it cannot be met by increased stand values. These disadvantages certainly do not encourage intermediate cuttings in pole stands of the white pine type at the present time.

Pacific Northwest

Harvest Cuttings - Douglas Fir. Before he left the Station Kolbe finished his report on the silvicultural phases of the installment cutting study made last summer on a tract of the Simpson Logging Company. The silvicultural

phases of this study, which Kolbe conducted through a large part of the last field season, involve the measurement of silvicultural damage and fire danger after each of five successive cuts by which a very heavy stand was removed in installments.

A final report has been prepared on a study started 15 years ago on several national forests to determine the survival and effectiveness of Douglas fir seed trees. A total of 8 areas were under observation; upon 6 of these the slash was burned and on 2 it was left unburned. One of the unburned areas was a typical old-growth stand, and it showed a survival of 26 percent of the seed trees; the other was a more open, wind-firm stand, and it showed a survival of 92 percent. The 6 slash-burned areas showed a survival of 2 to 23 percent with a 10 percent average. Windfall was the greatest single cause of loss and accounted for 38 percent of the total mortality.

The "after cutting" progress report has been prepared for the Parkdale selective logging plots. This area represents about the eastern limit of the Douglas fir region and may lend itself better to light selective cutting than the more dense stands on more moist sites nearer the coast. The average cut on the plots amounted to 25 percent of the total volume. This should give release to the residual stand but will probably not result in the establishment of Douglas fir regeneration as is anticipated. There is a light mixture of white fir in the stand and an occasional hemlock and western red cedar. The site is somewhat dry for the latter two species; therefore it is probable that white fir reproduction will predominate since it is more tolerant than the Douglas fir. After the cutting operation was complete there was a reserve stand of 68,500 board feet per acre.

Harvest Cuttings - Ponderosa Pine. Preliminary computations on Rogue River plot 5 and Deschutes plot 5, examined last summer 10 years after cutting, give the following annual mortality losses in board feet per acre, Scribner rule.

	Windfall	Insects	Other (logging and unknown)	All causes
Deschutes plot 5 - 1st 5 years	120.5	13.2	2.0	135.7
2nd 5 years	96.5	20.0	0.0	116.5
1st 10 "	108.5	16.6	1.0	126.1
Rogue River - 1st 5 years	8.4	1.7	2.4	12.5
2nd 5 "	2.8	6.9	0.0	9.7
1st 10 "	5.6	4.3	1.2	11.1

A heavy selection of about 80 percent volume removal was given both the 50-acre Rogue River plot and the 32-acre Deschutes plot. The heavy windfall losses on the Deschutes plot probably occurred because it is adjacent to extensive clear cuttings on private land.

Stand Improvement. Kachin assisted in the initiation of CCC stand improvement projects on the Fremont, Colville, and Mt. Hood Forests. Two going CCC pruning projects on the Willamette Forest were visited and a brief time study on 113 Douglas fir trees pruned 34 feet by the spur-Hebo club method was made. This study showed that an average CCC climber with a few days' experience can prune a 12-inch tree in 8 minutes of actual pruning time, which involves breaking off some 65 branches of about an inch in diameter. On a per linear foot basis this spur and Hebo club combination is the fastest of any methods tested thus far in pruning Douglas fir.

At the same time it was found that in using this method an average tree is damaged to an extent of 105 spur marks on the pruned 34-foot section of the bole. Sections of spur-climbed second-growth trees on some of the older telephone lines are being collected for a comprehensive study of the type and effects of the spur damage.

The first report on two and the second report on four Olympic thinning plots in 65-year-old Douglas fir at Mt. Walker was completed. The reserve stand on the thinned plots, from which about 43 percent of the cubic volume was removed five years ago, has fared poorly. Heavy mortality, not shared by the check plots, has demonstrated eloquently the hazards of radical and abrupt exposure. The gross diameter growth of the principal crop trees has not been greatly improved by the thinning, but that of the smaller trees has. The thinning has resulted in stimulated establishment of Douglas fir seedlings. An average of 2,600 per acre are now found on the thinned plots but only 170 per acre on the check. Although the reproduction is premature in the present case, with anticipated rotation age half a century away, the ability of Douglas fir to establish itself beneath a shelterwood following heavy crown opening is clearly demonstrated.

The establishment report for seven permanent sample plots on the Wind River Experimental Forest in 97-year-old Douglas fir thinned by commercial piling sale was completed.

Two sets of thinning plots at Pringle Falls show interesting results. One set of three plots is in a 60-year-old stand of lodgepole pine and the other set of five plots is in a 50-year-old ponderosa pine stand. The following preliminary figures have

been obtained.

	Lodgepole Pine Plots		
	25'x25' spacing	15'x15' spacing	Un-treated control
Annual gross growth percent (cu. ft.)	6.77	4.46	3.39
Annual mortality percent (cu. ft.)	1.05	.99	2.49
Annual net growth percent (cu. ft.)	5.72	3.47	.90

	Ponderosa Pine Plots				
	6'x6' spacing	Un-treated control	8'x8' spacing	Un-treated control	10'x10' spacing
Annual gross growth percent (cu. ft.)	6.07	4.59	7.63	4.61	6.45
Annual mortality percent (cu. ft.)	2.00	.10	1.29	.01	.42
Annual net growth percent (cu. ft.)	4.07	4.49	6.34	4.60	6.03

It will be noted that there is marked difference between the net growth on the thinned and unthinned lodgepole plots. This does not hold true in every instance in the ponderosa plots, due to the high mortality on the thinned plots from an infestation of Ips oregoni in the slash at the time of plot treatment.

Washington Office

Although much of the material in the following summary has been covered in Raber's "Water Utilization by Trees" M.P. 257, it does give a different slant on the subject which can bear repetition.

THE PRESENT STATE OF THE QUESTION OF THE DROUGHT RESISTANCE
By
L. A. IVANOV

Summary

A critical survey of the Russian and foreign botanical and partly agronomical literature leads to the following conclusions:

1. The point of view on which till now the investigations of drought-resistance have been based, and which regards transpiration as an inevitable drawback ought to be considered as erroneous when expressed in such general terms.

It is necessary:

(a) As the most economical means of translocation of mineral matter with the water current which must have a considerable velocity if one of the indispensible constituents is supplied from a very weak solution, as is the case with N. and P. in natural soils.

(b) As concurrence to the shifting of the enzymes and organical matter (Rywosch) without which a disturbance of the metabolism (Schlösing) occurs.

(c) As regulator of the turgescence.

(d) As regulator of the temperature.

2. The investigations of the last years are evoking strong doubts as to the regulation by means of stomata and by so-called xeromorphical characters (cuticula, hairs, wax) being of essential value for the reduction of transpiration. On the other hand in investigating the transpiration coefficients in the majority of cases, a direct connection between transpiration and the drought resistance of the plant has not been confirmed; the impossibility however of investigating in natural surroundings owing to the absence of an elaborated method of measuring the transpiration of plants "in situ" deprives those investigations of their decisive importance.

3. More definite and illustrative is the connection between the qualities of the root-system and drought resistance, for here, in the majority of cases, the plants are investigated directly under natural conditions. The drought resistance depends: (a) on the possible strength of absorbing capacity of the root, measured by osmotic pressure by means of the plasmolithic method. This capacity in common (not saline) soils influences not so much the limits as the rapidity of the water supply, (b) on the structure of the root system, which increases the drought resistance of the plant the more intensely it is developed in the layers containing moisture available for the plant. As such layers, even in droughty localities, are not always deep situated ones, no direct connection between drought resistance and the length of the roots has been observed in many cases.

4. Of not less importance for explaining a different drought resistance, but little investigated for different plants, are: (a) the conducting capacity of the stem, (b) the capacity of utilizing dew, (c) the capacity of reducing their dimensions (nanism) and the period of vegetation (ephemerism), (d) the capacity of reducing their vital functions without dying (anabiosis).

In literature there are but indications about the possibility of the plants utilizing those peculiarities in their struggle against drought.

In further investigation drought resistance as an ecological phenomenon ought to be studied through systematic observations in natural surroundings on biological stations and by means of specially elaborated methods. Facts thus established by observations must afterwards undergo an experimental physiological analysis.--Petrograd Forestry Institute, Bot. Lab., April,1922.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Cost of lumber manufacture in 1939. Philip Neff, logging engineer of Region One, and Bradner and Rapraeger of the experiment station have, on April 1, 1940, completed the annual canvass of the bandmills of the Inland Empire. Nineteen hundred and forty marks the twenty-fourth year that the canvass has been underway. Costs will be obtained from about 30 mills.

The mills report a decrease in lumber manufacturing costs in 1939 versus 1938, the decline amounting to about 70 cents per M feet or approximately 5 percent. The decrease is mostly due to larger production in 1939, which had the effect of reducing the per-M-feet cost of overhead items.

Most mills are in a favorable market position. Stocks on hand are low, and certain yard items such as numbers 4 and 5 common boards, are well nigh exhausted. Order files are good and events appear propitious for a favorable year in 1940.

Census. The second request to operators in this region was mailed on March 5. Over 300 edited returns resulting from the first request to Idaho and Montana manufacturers have been shipped to Washington. In addition, completed schedules covering about 60 percent of the manufacturers operating in Spokane, Pend Oreille, and Stevens Counties, Washington, have been forwarded to the Pacific Northwest Forest Experiment Station, Portland, Oregon.

Some 200 Idaho and Montana reports received in response to the second request are nearly ready to be forwarded to Washington. Returns from the first and second requests have accounted for 65 percent of the total number of lumber and timber products manufacturers on the mailing list for the region. A third request to all of the delinquents has been prepared.

Pacific Northwest

Lumber and Log Census. During the past month and a half, Johnson has devoted his entire time to the editing of the census schedules. This being the biennial census, a great deal of detailed information is requested. The inquiries are of such nature that they do not conform to the system of bookkeeping used by the larger companies and also are confusing to the smaller operators. This fact has necessitated a great deal of letter writing to secure additional and correct information. Also the fact that contract loggers have to be solicitated has greatly increased the work involved.

To date 763 edited schedules have been sent to Washington. Two requests have been sent out and a third will be mailed in the near future. About 1,200 operators have not yet been heard from.

TIMBER HARVESTING AND CONVERSION

Northern Rocky Mountain

Cubic-foot log scaling. The paper entitled "The Cubic Foot as a National Log-Scaling Standard" was distributed in January, and since then many comments have been received pertaining to the merits and demerits of the proposal. Most commentators agree that cubic-foot log scaling is fundamentally sound, but a great number conclude that considerable promotional work will be necessary to establish a change from board-foot log rules.

Larch for plywood. Two logs of western larch were recently sent to the Forest Products Laboratory at Madison to be made into rotary-cut veneer.

Whether larch is suitable for plywood is a shot in the dark, but it is hoped that something will materialize

from the experiment.

Pacific Northwest

Hemlock Plywood. A study of the practicability of using western hemlock and the "white firs" for plywood in which the Douglas Fir Plywood Association, the Madison Laboratory, and the Station are cooperating, got off to a flying start in March. Dr. Brouse represented the Laboratory, Mr. Arneson the Association, while Brandstrom and Lodewick were assigned from the Station. Logs of hemlock, noble fir, and amabilis fir were followed through plants in Tacoma, Hoquiam, and Everett, records being made of yields, quality of veneer, cutting qualities, etc. The consensus seems to be that suitable plywood can probably be made from these species, that the technical problems will not be too difficult, and the technical problems will not be too difficult, and that the economic problems of production at a reasonable cost may loom largest.

Pine Mill Studies. Field work on the check study begun at the J. Neils Lumber Company in January was completed in February, and the office computations are well along. It is too early to predict differences in marginal values between the logs from this tract and those in previous studies. But one fact is very evident, i.e., the extent to which changes in the items manufactured can affect yields and production. Comparison with the results of the study conducted last fall at the same mill with the same sawyers show that while a green-chain over-run of 10 percent was obtained in the earlier study an over-run of only 4 percent was obtained in the last study. This is directly attributable to a shift to a larger proportion of 5/4 and of 6/4 Dimension, both of which require a greater "set-out" on the headrig to obtain the same lumber tally. At the same time the hourly production was appreciably reduced, therefore, costs per M feet were increased.

Selective Timber Management in Douglas Fir. A report entitled "Volume Losses in Logging and Marketing Old Growth Douglas Fir", under the joint authorship of Brandstrom of this Station and George C. Flanagan of the Division of State and Private Forestry, has been completed. This report is based upon data obtained in the so-called Simpson study in which some 600 tagged and numbered Douglas fir veterans, ranging mainly from 50 to 90 inches in d.b.h. were followed through from stump to raft, for the purpose, among other things, of determining the amount and character of the loss in log scale that occurs at various stages of the operation. The area studied was practically level, the timber relatively sound, and unusual care taken by the operator to keep breakage to a minimum (by removing the timber in several cuts with tractors) and to utilize all merchantable portions of the trees. Despite this, the reduction in scale was surprisingly great, as is shown in detail in the following tabulation for the 70-inch d.b.h. class. Particularly

striking are the losses shown for the top logs, where only a small fraction of the gross scale in the standing tree comes through as net scale in the raft.

Summary of Volume Losses by 32-foot Logs

	Butt log	2nd log	3rd log	4th log	5th log	6th log	Total all logs
Top d.i.b. in inches	50"	45"	40"	35"	29"	22"	
Gross woods scale, bd. ft.	3744	3036	2408	1752	1218	668	12826
Broken sections left, bd. ft.	0	25	108	270	448	374	1225
Culled sections left, bd. ft.	390	94	143	123	180	152	1082
Cull logs removed, bd. ft.	48	57	72	113	110	48	448
Water scale adjustment, bd.ft.	251	219	159	95	37	7	768
Bureau scale deductions, bd.ft.	442	315	231	166	92	26	1272
Total loss, bd. ft.	1131	710	713	767	868	607	4795
Net Bureau water scale in bd.ft.	2613	2326	1695	985	351	61	8031
Net Bureau water scale in percent of gross woods scale	70%	76%	70%	56%	29%	9%	63%

Corresponding losses in terms of value are now being analyzed and will be reported upon in the near future.

FOREST AND RANGE INFLUENCES

FLOOD CONTROL SURVEYS

Alleghany - Northeastern

Watershed Surveys

Alleghany. Although the crew has been securing snow data in the upper reaches of the watershed, a relatively light snow year over the entire watershed resulted in little spring flood rise.

Upper Susquehanna. The upper reaches of this watershed are in Northeastern Station territory, but the lower reaches

fall in the Allegheny Station area. This winter the Upper Susquehanna had the heaviest snowfall in decades. The water content ranged from 7 to 15" with much of the snow blanket over submarginal idle land and open fields where it was especially susceptible to weather changes. Little snow remained in Pennsylvania, except in a few locations of higher altitude. The probable beneficial effects from shifting much of this land into forest use can be best shown by what happened.

A moderate warm spell at the end of March accompanied by normal rains resulted in heavy local flood damage on the New York tributaries and along the main stem in Pennsylvania at Sunbury, Kingston, Wilkes-Barre, and other points. In New York the heavy run-off came from the snow blanket. In Pennsylvania the damage was largely due to converging of the crests from the upper tributaries in New York. Local Pennsylvania tributaries did not contribute materially to the flood heights.

One week after the floods a snow blanket of several feet remained over parts of the New York watershed, and subsequent rains twice led to renewed flood fears. Had the rains and temperature been of the same degree as caused the 1936 St. Patrick's Day Pennsylvania floods, there is little doubt that all previous flood records on the Upper Susquehanna would have been broken and probably some on the Lower Susquehanna too.

Connecticut. The revision of the work plan has been held up due to inability to secure release of the revised U. S. Engineers' Report on this river.

Preliminary Examinations

Pequest. In reviewing this report questions have arisen as to the accuracy of the damage estimates and conclusions of nonseriousness in regard to the siltation problem. Both the state of New Jersey and the U. S. Engineers have requested access to our material. The Pequest situation is complicated by having problems of muck land drainage. Actual damage occurs from a rising water table which may never overflow the banks, but which, nevertheless, effectively drowns the crops. Too great an increase in stream capacity might lower the water table so far that drought conditions would do as much damage as the previous high water did. The solution appears to be mainly an engineering one, and changes in land use seem to offer little possibility of effective remedy to the present damage.

Appalachian

Preliminary Examinations

Efforts have been directed toward completion of the Big Sandy River Preliminary Examination Report, which should be completed within the next two months.

Considerable time has been spent in the development of a flood routing procedure adapted to use in preliminary examinations and on the watershed surveys.

Watershed Surveys

Substantial progress has been made on the Potomac River Survey, and work in practically all sections is on schedule. Increased field activity will be facilitated by the approaching good weather.

Land classification has been completed, and soils investigations, cover analysis, flood damage investigations, and hydrologic studies have made significant progress.

The Pee Dee River Survey, in which the Station is cooperating, is making satisfactory progress.

Central States

Preliminary Examinations

Committee 11-A (Forest Service chairmanship). The preliminary examination report on Wolf Creek, which empties into the Mississippi at Memphis, has been completed and submitted to Washington.

Field work on the Hatchie River has been completed by all three bureaus and the hydrology section written up. A field examination of the Cumberland River is scheduled for July or earlier if the Hatchie P. E. is completed as planned.

The uniformity of conditions on the Tertiary Plateau in western Kentucky and Tennessee are such that one detailed survey for the entire area including Wolf and Nonconnah Creeks, Hatchie, Loosahatchie, Obion and Forked Deer Rivers would be justified. It is probable that the Hatchie River P. E. will propose this combination. The sedimentation problem on all these streams is exceptionally critical. The Corps of Engineers fully recognizes that any economic program of

flood control on the bottomlands is dependent on the success of an agricultural program on the uplands.

Committee 4 (Soil Conservation Service chairmanship). This sedimentation problem is also critical in the Upper Wabash River. The Wabash P.E., which has just been completed, indicates that the formation of islands with subsequent bank cutting along the main stem from Logansport to Fort Wayne is destroying large acreages of bottomland farms as well as causing increased overflow and high annual crop losses.

Committee 14-B (Soil Conservation Service Chairmanship). The work outline for the Little Sioux River in Iowa and P.E.'s on the North Fabius, Chariton, Weldon, and Iowa Rivers have received high priority during the last two months. A joint survey with the Corps of Engineers is being proposed for the Little Sioux.

Detailed Surveys

St. Francis. The St. Francis survey report was submitted to Washington February 15, and is now before the Sub-committee for review. It was discovered on the St. Francis that sizable reductions in floods and flood damage could only be effected through a broad program. Consequently, the problem was analyzed on the basis of the possible use of flood control funds as a leavening agent in the initiation of a comprehensive and coordinated action program by all State and Federal agencies interested in land management and rural sociology.

Muskingum. A detailed survey report on Raccoon Creek has been prepared by the Party and reviewed by the Working Committee. It will be submitted to Washington about April 15. The field work for the entire Muskingum has been completed and it is expected that the survey report will be completed by June 30.

Lake States

Preliminary Examinations

Two preliminary examination reports are now nearly ready for submission to Washington. One covers three watersheds in North Dakota - the Pembina, Forest, and Park. The other report covers the Black River in Wisconsin, and should be ready after a little additional field checking.

Detailed Surveys

Work on the Whitewater has been largely confined to the office except for regular weekly excursions to the stream gages and the snow scales. The spring breakup occurred during the last few days of March. A fair-sized flood resulted which furnished much needed information on the relation of stages farther upstream to discharges at the permanent gaging station near the mouth. This flood was particularly good for this purpose because it originated evenly from all parts of the watershed and there were no difficulties from ice obstructions.

A new technique for making infiltration tests is being developed and will be tried out as soon as weather permits. An attempt has been made to devise a system which will be considerably faster in operation and will apply water in a manner more nearly approaching natural rainfall than the North Fork infiltrometer.

Pacific Northwest

Progress. The first rough draft of the preliminary flood control report for the Willow Creek, Oregon, watershed was completed and sent to the other members of the committee for comments. The final draft of the preliminary report for Moses Coulee, Washington, was assembled and submitted to Washington on April 3.

Walla Walla Watershed Survey. In March the Flood Control Advisory Committee authorized a survey for the Walla Walla watershed. Wallace Robinson, Administrative Assistant on the Ochoco Forest, was selected for Forest Service Senior Representative, and reported at Walla Walla late in the month.

Streamflow Studies. It is planned to locate the five recording rain gages which were sent to us from Washington in or near the Tillamook burn. This should do much to overcome the absence of meteorological data which has handicapped studies of the effect of this large fire on streamflow. Bolles, in cooperation with Mr. Fisher of the Weather Bureau, located two of these gages late in March. The others will be established in the near future.

Southern

Preliminary Examinations

An intensive reconnaissance of the Upper Red River was made by representatives of the three bureaus. Every tributary was inspected for flood damages, erosion, and physical factors that might influence the possibility of a remedial program. Particularly evident was the fact that many flood plains (especially in west Texas) were sandy wastes and direct flood damages are practically nil. The report is now in its final stages and recommendations for a detailed survey should be confined to those areas in which direct flood damages are significant.

Detailed Surveys. Work was initiated on the Upper White River survey on March 15. The Forest Service holds chairmanship

and C. F. Olson is the Project Leader. Some hydrologic investigations are under way but the field party is involved mainly in the preparation of work plans.

On the Upper Yazoo survey, preliminary phases are complete and work plans have been prepared and the investigative phase of the survey is in full swing. Area classification, based on strips for a 25-percent sample, is being done in the field with the use of aerial mosaics. Major delineations are made in the office and checked in the field, at which time further delineations are made on the degree of gully erosion and slope. Stereoscopic analysis of ratioed prints will be confined to sedimentation studies in the flood plains.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

Appalachian

Hydrograph Analysis of Streamflow. Well records have been used as a basis for determining the approximate variations in base flow of streams during periods of compound storms. This procedure supplements the use of standard depletion curves for separating storm run-off, especially during the large winter storms approaching the limits of readily determined depletion.

It has been observed that fluctuations in the water table have close correlation with the expected base flow in the stream. To be representative of the contribution of the whole watershed to the base flow of the stream and to be free from minor channel storage due to rises in the stream itself, a well located on a lower slope is selected. In actual practice, the time the well rises agrees with the time of maximum peak of the stream and is used as such in all cases. The time at which the well has reached its maximum elevation and starts to recede at a uniform rate is found to agree with the time the storm run-off ends as determined by the depletion curves. For calculation, these points are joined by straight lines.

During complex storms it has been found that a straight line relationship between changes in elevation of the water table and rate of flow of the stream gives consistent results for minor fluctuations involved during any one storm. Thus, for intermediate variations of the base flow during complex storms, the following procedure is used:

(1) Determine points where storm runoff begins and ends by normal depletion curve; these times may be as much as several weeks apart.

(2) Using these points as the known ratio between rises in the well level to rate of flow in the stream, the relative elevation of other points in the well records can be converted to c.f.s. and into head on the weir.

Streamflow Analysis. W.P.A. Research Project No. 4714, under the direction of the Division of Forest Influences compiled continuous stream records for 3,120 weeks and has provided a record of the mean daily discharge in cubic foot per square mile by days, months, and growing seasons. From the results obtained, graphs of annual discharge in mean c.s.m. have been prepared for each of 40 drainage areas.

Special analyses of water storage and base flow have also been prepared for five Coweeta Experimental Forest drainage areas and will be carried through for all drainage areas.

California

Errata. The last column in the table on page 63 of the February 1940 "Forest Research Activities" was accidently inverted. That is, in the case of no litter there were 1192 grams of erosion, for 1/8" litter a trace of erosion, and ½", 1", 1½" litter cover there was no erosion.

San Dimas Experimental Forest. On March 1, the San Dimas Experimental Forest staff formally occupied the new Forest Service building in Glendora. This structure, which is shared by the Baldy District Ranger of the Angeles National Forest, has united the several offices formerly necessary in the operation of the Experimental Forest and gives a closer tie with the District Ranger who is primarily responsible for the protection of the research area.

The 18-room one-story structure contains offices, conference, drafting, and computing rooms, storage facilities, a darkroom for emergency photographic work, and a fireproof concrete vault for records and data. The architectural scheme is Early Californian and the interior is finished in wood paneling. Work is still underway on the garage units and the landscaping of the grounds.

The site for the building was purchased and donated to the Government by local citizens through the Glendora Chamber of Commerce, and the building has been constructed with the aid of the Work Projects Administration.

Precipitation. The average rainfall for the month of February was about 6 inches, which is approximately 50 percent of the 6-year mean for the Experimental Forest, while March has been the driest since 1933 with only 2.20 inches as against a 6-year average of 5.35 inches. Most of this year's storms have been comparatively gentle and no high sustained intensities have been recorded.

Streamflow

Completion of streamflow tabulation through the 1938-39 season and computation of quantities have yielded some very interesting figures. The following table gives the rainfall-streamflow relations for the season. Records were incomplete for gaging stations VI and VII, which were put out of commission by flood debris.

San Dimas Experimental Forest
Rainfall and Streamflow
Season 1938-39

Watershed number	Rainfall inches	Runoff inches	Runoff in percent of rainfall	Peak flow	
				Cu. ft. per sec.	c.f./sec. /sq. mi.
			%		
I	19.78	3.95	20	15.6	6.4
II	22.02	2.75	12	117.8	53.1
III	22.26	3.42	15	25.3	11.8
IV	21.43	3.03	14	154.8	27.6
V	20.67	1.49	7	37.0	8.5
VI	20.57	Inc.	-	-	-
VII	19.94	Inc.	-	-	-
VIII	19.94	1.48	7	14.2	10.5
IX	20.49	0.92	4	0.6	0.5
X	19.70	1.47	7.5	7.0	5.1

Two very interesting relationships are shown by this table. The first is the very low runoff percent for the season. Low intensity storms allowed the maximum of infiltration. The next interesting feature is the comparatively high peak flows from Watersheds II and IV, compared with Watersheds III and V, respectively. It will be noted that the peak rate of flow from II was over four times that from III, and IV produced slightly more than three times that from V. These wide differences reflect the influence of the burned area in Fern Canyon. The effect of the 500-acre burn in this watershed even shows up in the discharge from 5.6 square miles of area which includes watershed II as measured at gaging station No. IV. Prior to the fire, conditions were quite different, as illustrated by the following data from 1936-37.

Watershed	Peak flow for season 1936-37	
	cu. ft./sec.	Sec.ft./sq.mi.
II	38.5	17.6
III	55.4	25.8
IV	129.0	23.0
V	204.0	47.2

It is indicated here that Watersheds III and V normally produced runoff peaks greater than those from II and IV, respectively, but now the relationship is reversed.

Complete analysis of the data will yields some very valuable quantitative figures upon the effect of this burn.

Runoff and erosion plots. The following brief summaries of the Fern and Tanbark Plots, for this season to date, show rather striking comparisons between the reactions of burned plots and cover unburned for 20 years.

Fern Runoff and Erosion Plots
Season 1939-40
Summary to March

Plots	Runoff in cu. ft. Per set	Per acre	Runoff in surface inches	Runoff percent	Remarks
341-342-343	147.5	1970	0.54	2.04	This set of plots completely denuded by natural burn in November 1938. Area not disturbed since fire.
344-345-346	72.4	964	0.27	1.02	This set of plots completely denuded by natural burn in November 1938. Area treated by felling all standing trees, lopping the limbs and placing boles and limbs horizontally across plots. Material held in place by stakes.
347-348-349	64.8	866	0.24	0.90	This set of plots completely denuded by natural burn in November 1938. Area treated by sowing with mustard.

Rainfall to date=26.41" Erosion(entire 9 plots)= 14 cu.ft./ac.(approx.)

Tanbark Runoff and Erosion Plots
Season 1939-40
Summary to date (March 15)

Plots	Runoff in cu.ft.		Runoff in surface inches	Runoff percent	Remarks
	Per set	Per acre			
321-322-323	8.21	109.5	0.03	0.14	Plots covered with 20-year-old chaparral, untouched since the fire of 1919
324-325-326	2.97	39.6	0.01	0.05	
327-328-329	1.68	22.4	0.006	0.03	

Seasonal rainfall to date = 21.15 inches

Seasonal erosion to date = Trace

Lysimeters. The recording system at the large lysimeters has been modified by the installation of jacks in the switchboard so that all seepage records go to one strip-chart recorder while the rainfall and runoff are recorded on two others. This will cheapen the cost of operation by cutting out one strip chart per week and will lighten very considerably the task of tabulation. A one-cubic-inch tipping bucket has been installed at the outlet of the seepage pipe of large lysimeter No. 23 above the tank in an effort to obtain a more intensive record of lysimeter performance. It is hoped that minute variations in percolation will show up through this means. One- and two-cubic-inch tipping buckets have been installed at the seepage and runoff outlets of medium lysimeter No. 1 in order to get a continuous record of its performance, thus supplementing the weekly weighing. The installation of several more is contemplated.

The low-sided rain-trough gages at the large lysimeters show an average variation of 4.2 percent below the catch of the high-sided gages for the season thus far.

The average seepage from the 26 large lysimeters amounts to 1.909 surface inches for the season to date. This is approximately the same as for last year at this time.

Intermountain

Temperature, because of its influence on the melting rate of snow, is an important factor in determining stream flow characteristics not only during spring run-off but, it is believed, during the entire year.

High temperature promotes rapid melting and high spring water yield through overland flow, but decreases the length of time available for a given amount of water stored in snow to penetrate into shallow and deep seepage storage channels. On the other hand, low temperature is favorable to a longer melting period, less early yield through overland flow, and greater infiltration into deep seepage channels where it may be stored for late flow.

An initial step in a proposed study of snow melting phenomena in relation to streamflow has been made by a compilation of temperature and run-off data from experimental watershed A at the Great Basin Branch Station. The data shown in table 1 were secured by plotting daily peak discharge in c.f.s. against daily peak thermograph temperatures for the first week after runoff began for years 1937-38-39. Confining the study to the first week following beginning of runoff provided rather constant snow cover conditions.

Although no actual measurements have been made yet, observations indicate that the rapid flow increase shown to exist above 53°F. results when the melting rate exceeds infiltration capacity of the soil and overland flow occurs. It is this overland flow which causes most of the soil erosion chargeable to melted snow water. At temperatures below 53°F. melting rate is about equal to or less than the infiltration rate and most of the flow results from "bleeding" of the A soil horizon as gravitational water in the soil strikes the less pervious B horizon. This gentle return flow from shallow seepage channels is accountable for a very large percentage of the water yield from the experimental area, but soil erosion from this type of flow is negligible.

It is interesting to note from the data that flow when the temperature is below 32°F. is almost constant even though temperature drops to 13 degrees. This was observed to be the case even though there was a cessation of melting for several days, indicating yield from shallow seepage channels.

Efforts during the coming spring will be directed toward a more comprehensive study of the related phenomena of temperature, snow melting, infiltration, overland flow, soil erosion, and streamflow.

Table 1. Mean water yield in c.f.s. in relation to temperature for 1937, 1938, and 1939 from experimental watershed A, Great Basin Branch Experiment Station.

Temperature degrees F.	Water yield in c.f.s.	Water yield increase in c.f.s. per 2° temp. rise	Water yield in percent of c.f.s. at 33° F.
13	.060	-	71
15	.060	-	71
17	.060	-	71
19	.060	-	71
21	.060	-	71
23	.060	-	71
25	.064	.004	76
27	.064	-	76
29	.068	.004	81
31	.072	.004	85
33	.084	.012	100
35	.096	.012	114
37	.112	.016	133
39	.124	.012	147
41	.144	.020	171
43	.168	.024	200
45	.192	.024	228
47	.224	.032	266
49	.264	.040	314
51	.312	.048	371
53	.380	.068	452
55	.512	.132	609
57	.680	.168	909

Rocky Mountain

Surface runoff and erosion. During 1937 and 1938 tests to determine rates of surface runoff and erosion were made on the abandoned field, valley bunchgrass, and mountain bunchgrass types in the Manitou Experimental Forest. Rain-simulating equipment applied rainfall artificially at intensities of two and four inches per hour to 1/200-acre plots.

Results show that despite 40 percent slopes on the mountain bunchgrass type, as compared to 10 percent slopes on the other two types, surface runoff was least on this type. Runoff was intermediate on the valley bunchgrass type, and greatest on the abandoned field type. The sand and gravel components and the amount of non-capillary pore space in the soil are greatest in the mountain bunchgrass type and least in the abandoned field type, indicating that

these factors, by increasing infiltration, are important in regulating surface runoff. Existing variations in density of plant cover apparently have no measurable effect on surface runoff.

The rate of erosion was greatest on the abandoned field type, where the soil particles are finest and density of plant cover is least. The mountain bunchgrass type, despite its high soil porosity, was intermediate in erosion rates, apparently due to the steepness of slopes which increased the velocity of overland flow. The lowest erosion rates were found in the valley bunchgrass type, located on gentle slopes with fairly porous soil, and supporting the highest plant density of the three types studied.

By increasing the rainfall intensity from two to four inches per hour surface runoff was more than tripled. The total amount of erosion also increased, but the amount of eroded material carried per cubic foot of surface runoff remained approximately the same.

Streamflow measurements. At the Fraser Experimental Forest the Fool's Creek gaging station is measuring streamflow underneath a cover of two feet of snow. With a salt solution to prevent freezing in the stilling well, continuous records are being obtained of the head on three bellmouth orifices.

In Missouri Gulch on the Manitou Experimental Forest the discharge from a 4700-acre drainage area is being measured at a recently completed station. This flow section consists of a two-foot San Dimas flume and two broad-crested weirs with a total capacity of 600 second-feet. The entire range of flow can be recorded in a single stilling well.

Snow evaporation. The snow evaporation pans at the Fraser Experimental Forest began to produce seepage water from snow melt on March 24. This coincided with initial wetting of soil outside the pans from melting snow. Daily observations of snow depths, water content, and seepage have been made since that time.

A snow column 15 inches deep above one 20 square-foot pan was dissected and analyzed by weight in layers to compare conditions on the pan with snow densities at two points outside. At each of the three points, a group of three horizontal snow cores was taken at each of three depths. In the lowest layer, a single block of snow was weighed at each location. The results of these tests are as follows:

Depth	Average snow density at three points			
	On pan	Just outside pan	Outside study enclosure	Average
Inches	Percent	Percent	Percent	Percent
3	33.33	34.36	33.34	33.67
6	33.04	34.50	31.84	33.13
9	33.77	35.67	32.74	34.06
12	38.78	43.04	36.01	39.28
Av. Percent	33.92	35.66	32.98	

Variance statistics

Kind	Degrees of freedom	Sum of squares	Mean square	F	Significance
Total	29				
Error	18	28.70	1.59		
Locations	2	37.19	18.59	11.69	HS
Depths	3	90.29	30.10	18.96	HS
Interaction	6	13.92	2.32	1.46	NS

A "t" test showed only the bottom snow layers to have a density significantly higher than the upper layers. The snow on the pan was "significantly" lower in density than that just outside the pan, but was not different from the snow sampled outside the study enclosure. It may safely be concluded, therefore, that the pan has little or no actual influence on snow densities above it, and that the indicated variations are random in nature. An interesting point is that with the minute variations existing in snow density on the area, even differences of less than 2 percent are statistically significant.

Southern

Jones Creek logging study. A preliminary survey of erosion losses from skid trails, logging roads, and concentration yards was made during March on an area of 160 acres in 4 of the 7 logging units in Jones Creek. Nine months before, two of the units had been clear-cut to 9 in. d.b.h. with a cut of 21 trees per acre and the other two selectively cut with an average cut of 6 trees per acre. It was found that on the clear-cut areas, 2.5 percent was laid bare by skidding operations and 3.6 tons of topsoil removed; whereas on the selectively cut areas, only 1.2 percent of the watershed was affected and less than 1.5 tons of topsoil removed per acre. Skid trails and roads, averaging over 300 feet per acre on clear-cut units but less

than 200 feet per acre on selectively cut units, contributed almost equally to the soil loss per acre, with the concentration yards making up less than 10 percent of the total soil loss.

An analysis was made of the soil losses from skid trails on two degrees of slope, less than 20 percent, and over 20 percent. The effect of slope was found to be highly significant. On clear-cut areas, soil losses were greater by 40 percent on steep slopes than on gentle slopes; and on the selectively cut areas, soil losses were 100 percent greater on steep slopes than on gentle slopes.

These preliminary results appear to open up a broad field for extensive studies of effects of logging on soil erosion. This preliminary study is being followed up by establishment of permanent bench marks on a representative sample of skid trails, logging roads, and concentration yards to obtain a more exact measure of soil loss in relation to soil type, slope, and adjacent cover. Permanent sample plots are also being established for a study of runoff and vegetative changes.

Southwestern

Evaporation losses on southwestern watersheds. The general system regarding water resources and water utilization in the Southwest may be briefly described as follows: Rain and snow produce runoff, runoff becomes streamflow, and streamflow is diverted directly from the streams for irrigation, or it is first stored in reservoirs and later released for use. However, the percentage of the total precipitation actually used is surprisingly small. Considering that part of the Salt River watershed which contributes water to Roosevelt Reservoir, we find that only about 15 percent of the average annual rainfall of 21 inches gets into the reservoir. Hence, there is a loss of 85 percent, or about 18 inches of water: evaporation from the ground, loss in and from stream channels, and transpiration from plants account for most of this heavy loss. The greatest loss is by evaporation of water from bare ground unoccupied or unshaded by vegetation.

Weighing experiments at the Parker Creek forest influences station show the evaporation loss from bare ground to be almost as great as the combined transpiration and evaporation draft from surfaces covered with vegetation. In these experiments natural soil blocks 12"x12"x22", encased in galvanized iron containers, are weighed weekly to determine water losses.

For convenience in comparing rainfall and evapo-transpiration losses, weights of water lost are converted into terms of inches. The data on weekly losses during 1939 show how great evaporation losses from the soil must be in comparison to transpiration losses from the plants comprising the vegetation cover. On bare blocks, 22.55 inches of a total supply of 28.18 inches evaporated back into the air. Blocks covered by grasses lost only 0.79 inch more. Apparently, grasses made most of their growth from moisture conserved by shading. However, the very small difference in water consumption between bare and grassed areas may be attributed in part to the unusual distribution of rainfall in 1939. Precipitation in January and February was unusually low. Summer rainfall was considerably above normal, and practically all of it was either lost through evaporation or utilized in transpiration.

Provision is made for draining off the free gravitational water from the cans in winter when water supply exceeds transpiration and evaporation losses. Inasmuch as the soil blocks were well filled with moisture at the beginning of the year, about $3\frac{1}{2}$ inches of water was drained from each of the containers in February and March to keep the plants from becoming waterlogged.

According to the data it is evident that soil moisture in the blocks became practically exhausted by June, and it was necessary to add 0.80 inch of water in June and 0.70 inch in July to keep plants from dying. However, when heavy rains came in August, evaporation losses immediately began to rise sharply. During this month evaporation from bare surfaces actually exceeded combined transpiration and evaporation losses from vegetated surfaces. The blocks with bare surfaces lost water very rapidly during the week immediately following rains. Blocks covered by vegetation lost less water immediately after rainy periods and consequently more water was available for use of plants in September.

Were it not for the fact that vegetation draws out the soil moisture at deeper depths where evaporation takes place slowly, evaporation losses from bare ground might even exceed losses from vegetated surfaces.

The drop in water loss from soil blocks in June and July is due to exhaustion of moisture rather than to other influences. Evaporation from a free-water surface is highest in these two months.

STABILIZATION OF SOILS

California

Erosion control and planting. The work of erosion control on the overcast fill slopes of that portion of the Fern Canyon road which is located in the 1938 burned area is practically complete. The slopes were treated by the standard method of wattling. Baccharis stakes were used to anchor the wattles, and the rows were interposed with drills of cereal grain. Similar work on portions of the Big Dalton road not previously treated have also been completed.

These stabilization measures were supplemented by planting the fill slopes with 1,300 potted shrubs of 30 different species. Many of the lots of shrubs were divided and half were planted at elevations of 5,000 to 5,500 feet along the Fern road while the other half were set out on the Dalton road at lower elevations of 2,100 to 3,000 feet. All these plants were staked and survival counts will be made at intervals to determine their suitability for road-slope planting. The planting stock used was grown in the Berkeley and Devil Canyon nurseries.

One thousand Coulter pine seedlings, age 1-1, bare-rooted, were planted south of Tanbark Flat along the entrance road. Three hundred Ponderosa pine seedlings and 40 Bigcone spruce were planted in the Fern Canyon burn.

Devil Canyon nursery. During the past planting season, 37,000 trees, both bare-root and potted, were distributed from the nursery to cooperators and other public agencies in southern California for reforestation and erosion-control use.

Southern

Roads

A working plan for a cooperative roadbank-stabilization study between the Ouachita National Forest and the Southern Forest Experiment Station has been completed. The plan covers the test of five treatments to road cuts on Forest Service roads in the Ouachita Mountain region. The treatments include: (1) application of weed mulch to a staked bank, (2) application of litter mulch with brush

covering, (3) sodding of topsoil-covered banks with 2- by 3-in. pieces of Bermuda-grass sod, (4) application of a 3-in. layer of mixed topsoil and Bermuda-grass stolons, and (5) Bermuda-grass seed sown on a 3-in. layer of topsoil applied to the bank. The five major treatments will be applied to roadbanks with 1:2, 1:1, and 2:1 slopes and three degrees of fertilizer application (no fertilizer, 2 lbs. per 100 sq. ft., and 4 lbs. per 100 sq. ft.) will be superimposed, giving a total of 45 treatments. The study is expected to be initiated sometime in April at CCC camps near the Irons Fork Experimental Forest.

Watersheds

Irons Fork Creek. The completion of the 7-ft. dam was reported in the last bi-monthly report. Stream-channel sections both above and below the dam have now been completed. As a basis for determining the effectiveness of the dam in reduction of peak flows, stream stages are measured periodically between and during storm periods to provide rough hydrographs of discharge above and below the dam. Measurements are also expected to furnish data regarding streamflow characteristics which will be of value in designing the correct rating structure to be installed when funds permit.

Rock Creek. The effectiveness of diversion-spreader systems in retarding the rate of streamflow on small headwater streams by diverting it into basins, pits, and trenches for subsurface drainage is, in part, dependent on the rate at which diverted water returns to the stream. To determine the rate of flow of the upper layer of gravity water, a total of 57 shallow pits 2 feet deep were dug in two to three lines between each of the 13 spreaders and the stream channel directly below. Observers take frequent periodic measurements of the water stage in a selected number of these pits during rains. It is expected that the rate of the water return to the stream channel will be approximately the rate of subsurface crest movement down the slope.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Species

Distribution of range plants. As a guide for species adaptability studies, and on the theory that many range plants may not completely occupy their full potential ranges because of topographic barriers to migration, a survey of the distribution of 80 important perennial range species has been initiated. Records have been taken from the collections at the herbaria of Brigham Young University, the University of Idaho Southern Branch, the Utah State Agricultural College, the University of Utah, and of the Regional Office. Personal communication, range surveys, and all available published works on the distribution of vegetation in the Region are being drawn upon. The collection sites of each species has been marked on separate regional maps and six major areas of absence have been tentatively delimited.

The Snake River Plains in Idaho, the Colorado River in southeastern Utah, and the desert of western Utah appear to be the major barriers to plant migration. The rugged, forested mountains of central Idaho occupy the principal area of absence as nearly half of the species under consideration have not been collected there. More than one-third are unreported from central Nevada, while one-fourth are unrecorded from southern Utah, and an equal number are distributed throughout the region.

The present incomplete distribution maps will serve as a guide for carefully directed field observations and collections to be made during the coming field season, since it is realized that some of the "areas of absence" may be uncollected localities.

When the distribution of each species is known, it will be possible to plan species adaptability studies more adequately. Systematic introduction of valuable species into isolated areas may help insure that the maximum number of adapted species will be available for each ecological niche.

Methods

Improved drill. Further improvements have been made on the modified grain drill which was developed in 1937 at the Arrowrock Substation for contour strip drilling of range lands with steep slopes. The outrigger arms were shortened about a

foot each, which makes the machine less unwieldly on obstructed areas and detracts nothing from its stability. Two of the five grain spouts were closed so that only three rows, about 16 inches apart, are now planted. The 5-disk arrangement has been replaced by two sets of three disks each. One set is turned to throw to the right and the other to the left. The two sets of three are arranged into three pairs placed back to back below the three grain spouts. Each disk is attached and operated independently of all of the others, making it possible to use either the right or left hand set in order to have all operating disks throwing downhill.

This arrangement adds much to the value of the drill. It allows the disks to cut deeper and more evenly. Each disk leaves a distinct furrow 2 to 4 inches deep and 3 to 5 inches wide, which is valuable in holding water where it will be of value to the young plants.

No special provision is necessary for covering as the sloughing of the sides of the furrows is sufficient to cover the seed from one-half to 1 inch deep.

Actual field tests indicate that the drill is an officient machine which can be used for large-scale range reseeding on slopes with gradient up to 65 percent.

Northern Rocky Mountain

Methods

Furrow vs Disk Drills for Reseeding. When seeded in the fall, thicker and more uniform stands of bluestem, crested and beardless wheatgrass were obtained in two seasons sowings at Miles City with the use of a deep-furrow than with a double-disk drill. More snow and rain is trapped in the furrows left by the former machine and it appears that this additional moisture, in the seed row carries the seedlings through short drought periods. It may also supply sufficient moisture for the seeds to germinate more promptly when the soil is exceptionally dry in the early spring.

While fall seeding normally gives better results than spring seeding at Miles City, spring seeding in a good year by using a double-disk machine gives the best results. This machine disturbs the soil much less than the deep-furrow drill and the seeds fall on a firm seedbed. This firm seedbed appears to be especially important for spring seeding because the soil which is disturbed by the drills does not have a chance to settle firmly before the seeds germinate.

Southwestern

Site Factors

Report of Pot Tests and Analysis of Soils of the Mesquite Sandhills on the Jornada. Results of pot tests of soils obtained from the top of a mesquite sand dune, from a barren interdunal blow-out, and from a typical black grama grass area on the Jornada show a considerable difference of productivity in the three soils. Tomato and corn plants, three plants of each species on each soil, were used in the tests which were carried out under greenhouse conditions. Distilled water was used to water the plants in order to avoid introducing any plant nutrients not naturally occurring in the soils. A measured amount of water was applied as the moisture conditions of the upper few inches of soil in the pots indicated the need, equal amounts being applied on the three plants of a species on the same soil. It was observed that both tomato and corn plants in the grama and dune soil soon outgrew those in the blow-out soil. As a result of this increased growth, the larger plants required more water to prevent wilting. The weights of top tissue produced by the plants grown on the three soils is shown in table 1.

The table shows clearly the large difference in production made by the plants in the three soils. As measured by the average production of the corn plants, the blow-out soil is but 0.62 as productive as the black grama soils, while the dune soil is 5.82 times as productive as the black grama soils. The tomato plants also indicate similar difference, the blow-out soil being 0.16 that of the black grama soil, and the dune soil 3.40 times that of the black grama soil.

Table 1. Production of plant tissue of plants grown on black grama, blow-out, and dune soils (over-dry weight in grams).

Tissue	Soil		
	Black Grama	Blow-out	Dune
	Grams	Grams	Grams
Corn tops	3.97	2.83	25.83
	5.22	2.28	29.15
	4.81	3.63	26.31
Average	4.67	2.91	27.10
Tomato tops	9.53	1.65	30.02
	9.91	1.65	33.48
	8.55	1.24	31.42
Average	9.33	1.51	31.64

Mechanical analysis and pH determinations were made on the soils used in the pot tests and, in addition, on the soil from a stand of snakeweed in the mesquite sandhills. These tests did not reveal any differences that would account for the considerable differences of productiveness demonstrated. Chemical analysis of a 1:5 water extract of the soils showed some important differences in the soils. The results of the analysis are shown below in table 2.

Table 2. Concentration of certain ions in 1:5 water extract of black grama, blow-out, dune, and snakeweed soils (parts per million on dry soil basis).

Ion	Soils			
	Black Grama	Blow-out	Dune	Snakeweed
	ppm	ppm	ppm	ppm
Ca.	60	15	90	15
Mg.	7.5	15	0	7.5
Na.	34.5	25.5	77	27.4
Cl.	10	10	30	20
CO_3	0.0	0.0	0	0.0
HCO_4	292.8	171	414.8	122
SO_4	0.0	T	0.0	0.0
NO_3	2.9	.6	12.5	.3

The analysis shows carbonates and sulfates to be absent from the soils and sodium, chlorides, and bicarbonates to be present in low and not widely varying concentrations. Owing to the unimportance of these ions in plant nutrition and to the lack of any marked variation in their concentrations they do not appear to account for the observed difference in production.

Magnesium concentration as shown by the analysis is lowest in the dune soil, intermediate in black grama and snakeweed soil, and highest in the blow-out soil. The values for dune and black grama soils are not consistent with the performance of the plants themselves, none of which exhibited chlorosis, the chief external symptom of magnesium deficiency. Concentration of calcium and nitrates in the three soils studied by pot tests show rather close correspondence with the production of top tissues of the plants grown in the respective soils, indicating that either calcium or nitrates or both were limiting to the growth of the test plants in the blow-out soil and to a lesser extent in the black grama soil. Figures for blow-out and snakeweed soils do not indicate any difference in productiveness is to be expected between these two soils.

Leaves of the tomato plants grown in the blow-out soil compared closely with leaves of tomato plants grown in solution lacking nitrogen, in exhibiting a conspicuous dark coloration along the veins. Leaves from plants grown in the black grama soil showed the deficient symptom to a lesser degree. There was marked contrast between the normally expanded leaves of the tomato plants grown in all three soils tested and the severely curled leaves of calcium starved tomato plants. This correspondence with the nitrogen deficient symptom indicates rather clearly that low nitrogen content of the black grama soil and still lower nitrogen content of the blow-out soil, as compared to the dune soil, is responsible for the observed differences in production in the three soils.

From these tests it may be concluded that:

(1) A difference in productiveness exists between black grama, blow-out, and dune soils, in this area the blow-out soil being less productive than the black grama soil and the dune soil being more productive than the black grama.

(2) The difference in productiveness is definitely related to the relative concentration of nitrate in the soils, the nitrate deficiency being marked in the blow-out soil and slight in the black grama soil.

(3) Although no plants were grown to maturity, the indications are that low nitrate content of the blow-out soil is definitely limiting for both tomato and corn plants and that nitrate content of the black grama soil is low enough to prevent satisfactory development of corn but may support moderate thrift of growth and yield of tomatoes. It may be speculated that the low nitrogen content of the blow-out soils, which is definitely limiting to the success of the relatively high-producing, high-demanding cultivated annuals used in the test, might be only retarding and not actually preventive of the successful establishment and continuation of the hardier native species of concern in the field.

(4) Since the blow-out and snakeweed soils are very nearly the same with respect to the ions analyzed for and especially with respect to nitrate content, and snakeweed plants grow thriftily on the snakeweed soil, it is unlikely that snakeweed is prevented from growing thriftily on the blow-out soil by lack of plant nutrients.

GRAZING MANAGEMENT

Intermountain

Summer Ranges

Boise range plots reanalyzed. A recent analysis of Boise range study data indicates that protection from grazing holds considerable promise as a natural range revegetation measure, but that continued heavy use of already badly depleted ranges is almost certain to result in nearly complete destruction of the most valuable perennial forage species.

The study consists of annual and biennial remeasurements of permanent plots located at a number of study areas which have been established to represent various range types and conditions on the watershed. At each study area a number of 5 x 5-meter plots that have been protected by an enclosure since 1930, and a number of plots outside the enclosure have been open to continued use.

The analysis is based on the densities of perennial grasses measured by the area-list method on 20 pairs of plots, each representing protected and grazed conditions. These plots were paired on the basis of field examination made near the beginning of the study. As some of the grazed plots have been measured only

biennially, the last complete record available is that of 1937. Consequently, the analysis was made by comparing 1931 and 1937 densities.

A preliminary arithmetical examination of the data from 40 paired plots showed that, in spite of the adverse weather conditions which have prevailed since the study was begun, the mean density of perennial grasses on the protected plots has remained practically constant, whereas the mean for the grazed plots has decreased about 46 percent during the 7 years of continued grazing. The following table compares the mean densities of perennial grasses on the 20 pairs of grazed and protected plots for the years 1931 and 1937.

Treatment	Mean density on 20 plots		Percent change
	1931	1937	
Protected	.01475	.01445	- 2.0
Grazed	.0145	.0078	-46.2

Analysis of variance, when applied to the individual plot data on which the above tabulation is based, showed that the apparent difference in trend between the protected and grazed conditions is real and highly significant. The 2 percent decline on protected plots, however, is not only very minor, but is fully within the variations that arise in measuring the densities.

The data in the table illustrate the disastrous effects of the continued use of already overgrazed and weakened ranges, especially during period of extreme drought. The fact that the perennial grasses on the protected plots, which were badly depleted in 1931, have held their own during the recent drought is a good indication that a significant recovery is likely when more nearly normal precipitation is received.

Spring-fall ranges

Sampling in native sagebrush-grass range. The use of sample plots in range studies cannot be avoided, since there is no practical way of harvesting all the plants on an entire area. Especially where shrubs are part of the plant cover and protect weeds or grasses from being fully utilized by grazing, estimates of the forage are sure to be subject to large errors which should be reduced by any feasible method that can be

devised. The variability in the yield of native vegetation from one plot to another is also large and this must be taken into consideration. In beginning a study, a range worker needs to know what size and shape of plot is most suitable and what method of sampling is most reliable.

A study of this problem on native sagebrush-grass range was conducted at the U. S. Sheep Experiment Station, Dubois, Idaho. Total herbage yields of arrowleaf balsamroot and tapertip hawksbeard were harvested from 640 5 x 5-foot plots, and these analyzed as to efficiency of various size and shape of plots and method of sampling. Both balsamroot and hawksbeard showed that plots 100 square feet in area gave much nearer to a normal discurve than did plots of 25 square feet. Plots must be large enough to provide a cross section of the distribution of scattered plants in a mixed population. Obviously, if the plot is small enough it may occasionally lie entirely between individual plants of scattered species, or include only one or two of them when the average number per plot is five or six plants. This failure to include species or to include enough of them, gives rise to badly skewed distribution curves, which with balsamroot and hawksbeard occurred on 25-square-foot plots but was largely overcome by 100-square-foot plots. Still larger plots of 400 square feet did not, however, give another proportionate advantage, indicating that for these species approximately 100 square feet is the proper size of sampling units.

In cultivated agriculture long, narrow plots have been found to include such variability as soil heterogeneity more fully than square or broad-oblong plots. In the range study at Dubois the difference in favor of long, narrow plots as compared to square plots was so slight as not to warrant any appreciable extra effo or time in laying them out. Circular plots are most quickly and cheaply established, as one permanent peg at the center designates a circular plot, the boundary being easily established. Line plots, consisting of four 25-square-foot plots spaced 5, 15, and 35 feet apart were found to be most efficient of all and to be easy to apply since they resemble systematic plots in this respect.

In deciding on sampling methods there are three considerations to be kept in mind:

1. Obtaining the mean within reasonably narrow limits of accuracy.

2. Arriving at a valid estimate of error for the mean.

3. Feasibility and ease of applying the method in the field.

At Dubois, systematic sampling at mechanical intervals was compared with straight random and stratified random sampling and it was found that systematic sampling at mechanical intervals was easiest to apply and was most effective in mapping vegetation type lines. Random samples, in which every possible sample unit was given an equal chance to be included, took some extra time and was somewhat awkward to apply in the field. Variance for the mean yield was somewhat, though not significantly, greater than for systematic sampling. Stratified sampling, wherein lineplot samples were drawn within each fourth of the area gave a smaller variance, not however significantly different from that obtained by systematic sampling. Since the cost in time was only slightly greater with stratified random sampling and since a valid estimate of error could be obtained, it is favored as the most desirable sampling method. A valid estimate of error is a highly valuable result to obtain as it can be used to approximate the intensity of sampling necessary to arrive at limits of error within 5, 10, or 20 percent accuracy for the mean forage yield. With the estimate of error it is then possible to compute whether the intensity of sampling required to get a 10 percent accuracy is justified in comparison with a 15 percent or 20 percent accuracy. Stratified random sampling supplied 29 percent more information regarding balsamroot and 22 percent more regarding hawksbeard than did strict random sampling.

Utilization Standards

Local and yearly variations in volume-height relationship. During 1938, volume height scales were made for 23 forage species common to summer range lands or study areas in the vicinity of the Great Basin Branch Station. Some of the difficulties encountered in the application of these scales to field use have been reported in bi-monthly reports for April and June of last year. This study was continued for seven of the most important species during 1939, the growing season of which was considerably different from that of 1938 in that the inception of growth was fully 2 weeks earlier and was followed by a protracted summer drought. These differences undoubtedly are registered in the greater variability in growth forms of the various species noted during these two seasons.

That mean maximum height in 1939 in general was roughly 80 percent that of 1938, is shown for the seven species studied in the following tabulation:

Species	Mean maximum height (inches)		Percent
	1938	1939	1939/1938
Agropyron pauciflorum	23.4	18.8	80.3
Agropyron cristatum	25.3	19.6	77.5
Bromus carinatus	28.3	23.3	82.3
Bromus inermis	24.2	22.8	94.2
Stipa lettermani	20.4	17.6	86.3
Osmorhiza obtusa	22.0	17.2	78.2
Agastache urticifolia	31.8	24.4	76.7

Volume and weight of production are found, however, to vary more markedly than maximum height. In most instances, a few flower stalks attain maximum height for any given plant, whereas the number of flower stalks produced is apparently a more direct response to favorable or unfavorable growing conditions than the greatest height of the flower stalks. The volume of basal herbage is a similar response.

In 1938 the removal of 50 percent of the height from plants of slender wheatgrass and mountain brome in any height class resulted in the removal of approximately 25 percent of the volume. There was remarkable uniformity in 1938 between the various height classes for each species, the plants all having a very similar growth form. In 1939 the removal of 50 percent of the height of mountain brome plants in the various height classes resulted in the removal of from 14 to 26 percent of the volume. When the entire sample is considered, with plants ranging from 12 to 40 inches in height, the removal of the upper 50 percent of the height resulted in the removal in 1938 of 18 percent of the volume and 11 percent in 1939. For slender wheatgrass the corresponding values were 6 and 2 percent of the volume.

Under actual range conditions such light intensity of use rarely occurs and accordingly the above comparisons are of little consequence other than to indicate seasonal variation in distribution of forage volume which tends further to complicate the application of volume-height scales to field use. A comparison of the 1938 and 1939 material indicates that the volume distribution in 1939 was much nearer the ground than in 1938.

Species	Percent volume removed when clipped at:							
	3 inches		4 inches		5 inches		6 inches	
	1938	1939	1938	1939	1938	1939	1938	1939
A. pauciflorum	75.8	64.9	67.8	53.3	60.4	43.3	53.6	34.0
A. cristatum	80.6	74.1	73.6	64.5	67.1	57.2	60.8	49.3
B. carinatus	78.5	73.5	71.3	65.1	64.6	57.4	59.0	50.4
B. inermis	78.2	75.0	69.9	66.3	62.3	57.9	55.1	49.8
S. lettermani	61.8	60.7	52.4	50.6	44.7	41.9	38.5	34.5
O. obtusa	86.4	86.2	81.0	79.3	76.0	71.6	71.1	63.1
A. urticifolia	90.8	86.1	87.5	81.7	84.6	77.0	81.7	72.2

It will be noted in the above table that in the case of grasses, roughly from 25 to 40 percent of the volume in 1939 was below 3-inch stubble height, and in the case of weeds, some 14 percent is below this level. The difference between the 1938 and 1939 material was greatest for slender wheatgrass with 11 percent and mountain brome with 5 percent. At the 4-inch level, now adjudged to be the approximate level of proper use, these differences are even greater, being 14.5 and 6.2 percent, respectively for slender wheatgrass and mountain brome.

Local variation cannot be fully evaluated owing to difference in size of sample. However, for any given species the 1939 material appears to vary more between zones than do the 1938 samples.

The local and seasonal differences noted between the 1938 and 1939 samples indicate that the application of volume-height scales to field use will necessitate preparation of new scales each year. Especially would this be necessary for tall growing bunchgrasses and rank growing herbs where differences of 5 to 15 percent are noted between the two seasons for levels approximating proper use. For such species as smooth brome, Letterman needlegrass, where less variation was observed, and possibly for some of the bluegrasses (not studied in 1939) volume-height scales may have fewer restrictions.

These volume-height scales bring out another point that needs careful consideration in range management, that of expressing the degree of utilization as percentages. For example, in 1938 a stubble height of 4 inches would have left approximately 30 percent of the current herbage of slender wheatgrass or mountain brome. In 1939 the same stubble would have left 47 percent of the current herbage of slender wheatgrass and 35 percent mountain brome. In actual amount of herbage, however, there would have been no more left, if as much, in 1939 as in 1938.

Summer Ranges

A visual method of analyzing chart-quadrat records. A method of using overlay copies has been found helpful in analysis of the charts from meter-square permanent quadrats. Quadrat charts may be used for other purposes in the study of vegetation, but perhaps their unique value is as a means of studying the interactions between individual plants in the process of vegetal change. This value is retained and enhanced by the overlay method.

A long series of accurate charts is to be desired, but a long series almost necessarily means a lack of unity in method, because in a long period there are bound to be shifts in interest and personnel. The result is a series which is difficult to evaluate and analyze. Even with close supervision and adherence to written instructions, representation of the same vegetation by different charters or even by the same charter at different times, is apt to be highly variable. Thus a grass clump will be represented at one time as an outlined area, at another time simply by a series of "spots" or dots. Differences in identification are bound to occur, for even well-trained assistants are not taxonomically infallible. Finally, under the conditions of most field work, some plants are overlooked. When close supervision is lacking, which is likely to be the case somewhere in a long-time record, variations like these are greatly magnified, and the confusion is increased by diverse orientation of the charts and diverse symbolism from year to year.

As a result, mere quantitative analysis on the basis of tabulation is difficult because it is "blind", and visual qualitative analysis using the basic charts is handicapped by a confusion of detail. With both methods it is easy to make errors, but difficult to detect them.

Under these circumstances it has been found necessary to prepare a second series of charts for each quadrat, uniform throughout in orientation and symbolism. Such a chart is made as follows: A sheet of semi-transparent (thin manifold typing) paper is clipped as an overlay to the standard quadrat chart. The upper and lower boundaries are ruled and the corners are marked. Outlines and symbols from the chart are then traced on the overlay, using a combination of geometrical symbols, letters, and colors to represent the various species. On account of the large numbers of plants on the quadrats and to avoid crowding and confusion on the overlays, broad groups, such as grasses, perennial herbs, and shrubs are confined to separate overlays. The separation of even one plant from others on the quadrat is undesirable, since it tends to obscure possible interrelationships; but inasmuch as the overlays are semi-transparent, such interrelationships may still be studied by superimposing different groups from the same chart.

Having a series of overlays results in several advantages:

1. A rapid comparison can be made to discern major trends. The unit in such a comparison is not so much a single plant as the family or clon. Increases, decreases, or fluctuations which are puzzling, when reported as a combination of numbers and area in a table, are quickly and easily evaluated.

2. Individual plants may be followed readily from chart to chart because of the transparency of the paper. This feature permits easy correction of misidentifications and omissions.

3. The bulk of the work--separating the wheat from the chaff--can be handled by unskilled clerical labor, leaving the technical man free to devote his energies to the essentials of analysis.

Approximately 2,000 overlays of this sort have been prepared for quadrat charts from the Great Basin Branch Station files, using WPA "white collar" workers. The preparation of each overlay, together with a careful check by another worker, required an average time of about half an hour.

Northern Rocky Mountain

Shortgrass ranges

Density changes - Hogback and Custer Flat major plots. Data recently compiled from 19 pairs of major plots on the summer cattle pastures at Miles City and 35 sets of plots on the sheep pastures, embracing 1,100 quadrats, .3 x 1 meter, show a continued shifting of density and species composition. Plots on the cattle pastures which date back to 1937 show a general increase in total density since that year and especially from 1938 to 1939. However, little bluegrass (Poa secunda) has gone counter to this upward trend. On the grama subtype this species had in 1939 only about 47 percent of the 1937 density and about 18 percent of the 1938 value. This decrease seems to be due to dry conditions during last April and May when bluegrass does much of its growing. Density of grama grass (Bouteloua gracilis) doubled and quadrupled in different subtypes in 1939 over 1937. Buffalo grass (Buchloe dactyloides), the density of which dropped very low during the drought years, increased more than eight-fold over the density of 1937. Most other species have increased from 50 to 100 percent during the two years.

Data from the plots on the sheep pastures which cover

only one year, 1938 to 1939, tell a similar story. The decreases of little bluegrass (51 percent) and forbs (71 percent) carried enough weight to cause a 2 percent decrease in total density when actually most other species increased quite markedly. Little bluegrass made up about 75 percent of the perennial grass density in 1938 and only about 47 percent in 1939. However, its value is limited largely to the spring months so the decline may be somewhat discounted in the total forage supply. Grama grass on the plots increased 130 percent during the year, while Agropyron smithii and Carex filifolia increased only 7 and 9 percent. With the exception of bluegrass, recovery from the drought years by most species is very striking. When bluegrass is omitted from the totals, other perennial grasses show a 66 percent increase in this one year and all other species show a 26 percent increase.

Southwestern

General

New cooperator on Santa Rita. On March 15 Mr. Fred S. Kimmerling, formerly with General Motors Company, completed negotiations for the acquisition of Mr. Wirt D. Parker's ranch holdings on the west side of the Santa Rita Mountains; these included the cooperative agreement on the Santa Rita Experimental Range, the adjoining forest permit, all patent holdings, State and private lands, and 400 head of breeding cows. Thus, the 21-year period of cooperation with Mr. Parker closed.

Mr. Parker came to the Santa Rita in 1919 and at that time had to borrow the money to purchase the MacBeath outfit of some 500 head: 200 head on the Santa Rita and approximately 300 head on the adjoining Coronado Forest range. In 1927 Parker acquired the Gardner Ranch on the east side of the Santa Rita Mountains, together with a forest permit of 134 head of cattle. In the year following he acquired the Nicholson holdings, which included a cooperative agreement to run 500 head on the Santa Rita, a small forest allotment, patented holdings, and State leases. Parker's entire holdings at the close of 1928 enabled him to run close to 1,100 head of cattle.

During his 21 years of operation on the Santa Rita, Parker sold 6,818 head of cattle (all ages), involving a gross return of $193,000, from the experimental range area alone. From his entire outfit (including the Santa Rita) he sold some 11,846 head of cattle with a gross return of $337,300. By the early thirties Parker was entirely out of debt, despite the fact that during the middle twenties he was involved in two bank failures; one of which cost him almost the entire proceeds of his fall sales that

year which were deposited in the bank the day before it failed. During the period of his ownership Mr. Parker has improved the grade of cattle on the Santa Rita from mediocre to seven-eighths purebred or better. In leaving the Santa Rita Mr. Parker will continue operation on another ranch property which he has acquired a few miles south of the experimental range. Here he plans to operate a combination breeding-cow and steer outfit in connection with the Gardner Ranch property.

Mr. Kimmerling plans to erect a headquarters on the old MacBeath homestead and will continue to operate the ranch on a breeding-cow basis, with a view to building up the outfit and turning it over to his two boys as soon as they have completed their education.

Utilization Standards

Cooperative Goat Range Study. A recent analysis of the utilization data obtained during November 1939 on the Young Ranch near Kirkland and the Raney Ranch near Skull Valley in connection with the cooperative range goat study indicates that full use of most of the browse plants in this chaparral type cannot be made, except at the expense of overuse of the perennial grasses which constitute a minor but extremely important component of the plant cover.

In the fall survey utilization data were obtained by clipping 25 clumps of each important grass and 200 twigs of each important shrub within three fenced enclosures representing different range types on each of the two ranches, and an equal number of grass clumps and browse twigs on the grazed areas immediately surrounding the fenced plots. All the clumps and twigs clipped were selected at random in an attempt to obtain bias-free samples. The grasses were clipped to ground level and the browse twigs were clipped so as to remove the current year's growth.

A summary of the clipping data obtained at two representative plots is shown in tables 1 and 2.

Table 1. Utilization data based on clipping at Plot No. 2 on Young Ranch.

Species clipped	Comp.	Utilization 1/	x Comp.	CPUF 2/	x Comp.
	Percent	Percent		Percent	
Blue grama	8	42	336	40	320
Shrubby buckwheat	15	48	720	46	690
Oak	29	28	812	27	783
			1,868		1,793
$\frac{1,868}{1,793}$ = 104% or 4% overused					

1/ Based on weight of clippings obtained within and outside of fenced plot.
2/ Corrected proper use factor.

The data in table 1 were obtained from a plot located within and representative of Pasture 1 on the Young Ranch. The range survey made in 1938 showed that this pasture with 800 surface acres had a computed forage acre value of 97 forage acres for goats and 90 forage acres for cattle. During the past grazing year it has been stocked with cattle only. While the plant cover is mainly browse, grasses make up about 20 percent of the total composition.

As results elsewhere have indicated that the stand of such perennial grasses as blue, black, and side-oats gramas can be maintained or improved on similar ranges, provided these species are not overutilized, and inasmuch as it appears that the maximum grazing capacity and greatest soil stability are to be found where the natural grass-browse composition is maintained or restored, proper use for the type as a whole was based on the proper use of these grass species. Comparisons of the relative palatabilities were made, therefore, on the basis of the most highly relished species present, which in most cases was blue grama, but where this species was absent, either side-oats or black grama were used as a base, according to the following formula:

$$\frac{\text{Actual use of blue grama}}{\text{Proper use of blue grama}} = \frac{\text{Actual use of associated plant}}{\text{Proper use of associated plant}}$$

Compared to blue grama with a known proper use factor of 40 percent by weight, the shrubby buckwheat and oak brush are calculated to have a relative proper use factor on a weight basis of 46 and 27 percent, respectively, and on the same basis the type as a whole is computed to be slightly overused (104 percent) as of November 20.

Table 2. Utilization data obtained from clipping at Plot No. 3 on the Raney Ranch.

Species clipped	Comp.	Utilization 1/	x Comp.	CPUF 2/	x Comp.
	Percent	Percent		Percent	
Black grama	15	7	105	4	60
Side-oats grama	10	54	540	33	330
Oak	29	11	319	7	203
			964		593
$\frac{964}{593}$ = 162% or 62% overused					

1/ Based on weight of clippings obtained within and adjacent to the fenced plot.
2/ Corrected proper use factor.

The data in table 2 were obtained from a plot located in and representative of pasture No. 3 on the Raney Ranch. This pasture is predominately browse but contains a relatively greater amount of grass than Pasture 1 on the Young Ranch. It has 1,321 surface acres with 154 forage acres for goats and 159 forage acres for cattle. During the past year grazing has been mainly by goats and partly by cattle at a rate approximately five times that of proper as estimated by range survey data.

Table 2 shows that up to November 20 side-oats grama had been used 54 percent on a weight basis and that black grama and oak brush had been used 7 and 11 percent, respectively. On the basis of an allowable volume removal for side-oats grama of 33 percent by weight and with a view to perpetuating this grass, although it constitutes only 10 percent of the total vegetation, the relative palatability of black grama under conditions of yearlong grazing by cattle and goats is only 4 percent and that of scrub oak only 7 percent for the year 1939. On the basis of these corrected proper use factors the type as a whole has been overgrazed by 62 percent up to November 20.

It is probable that the current grazing of the grasses will have decreased during the remainder of the winter and spring and that relatively greater use of the browse plants will have been made during that period. Utilization data comparable to that obtained in November were obtained on the plots again in March 1940, and analysis of these data should

indicate whether this is the case.

The data so far obtained in this study indicate that there is a great amount of variation in the relative palatability of specific plants growing in different plant associations and point to the need for much more study before definite proper use factors can be safely assigned to the various plants on these ranges.

COOPERATING BUREAU PROJECTS

BIOLOGY
(In cooperation with the Bureau of Biological Survey)

Northeastern

Forest Wildlife Relationships Project. Preparations are underway to root a number of cuttings from wildlife food shrubs at Hopkins Forest for use in an experimental comparison between rooted cuttings and seedling stock. Results obtained in establishing shrub clumps with a minimum of effort on failed spots in coniferous plantations, or in wide interspacings, indicate 1-0 stock unsuitable for plantation conditions in the Northeast.

The widespread impetus given forest wildlife investigations by the various states with their wildlife restoration programs under the Pittman-Robertson Act has made it advisable to revamp the program at this Station. Much of the work formerly considered in the scope of this project is now going ahead rapidly with much more adequate financial support than was previously possible. The revised program for the Station Biologist will stress the effects of silvicultural practices on wildlife populations, and the value of variously modified vegetative types for wildlife.

ENTOMOLOGY
(In cooperation with the Bureau of Entomology and Plant Quarantine)

Appalachian

Bark Beetle Control. The abnormally low temperatures during this past winter apparently counterbalanced the effects of the 1939

drought on the populations of the southern pine beetle, Dendroctonus frontalis. In outbreak areas of shortleaf and pitch pines on the Pisgah National Forest and the Great Smoky Mountains National Park, almost 100 percent mortality of beetle brood was recorded from counts of larvae, pupae, and adults.

A Pisgah National Forest project of bark beetle control by exposure of the infested bark to solar heat (maximum air temperatures of 95 degrees F.) was conducted in the late summer and fall of 1939. It resulted in only partial success, mainly because of the inaccessibility of the area and the lack of man-power and time, but the subzero temperatures of January (minimum air temperature of -6 degrees F.) apparently completed the control.

Northeastern

Status of European Spruce Sawfly in the United States in 1939. In general, the entire spruce area of New England and New York is lightly infested with the European spruce sawfly, while there are several local areas of very heavy feeding. During 1939 there has been little change in the intensity of the infestation over the general area, but some of the heavy local infestations have increased considerably. In Maine, H. B. Peirson reports an increase in the intensity of the infestations in the northern and eastern parts of the State. In the southern part of New Hampshire the severely affected area increased in a wide circle around Dublin where it was first observed. About 100 square miles became heavily infested, but feeding was greatly reduced in stands which previously were heavily attacked. The same conditions took place in southern Vermont near Wilmington. The heavily infested area now includes between 50 and 100 square miles, but trees heavily attacked in 1937 and 1938 were not seriously fed upon in 1939. In central Vermont near Lincoln the whole infestation has decreased noticeably. In New York conditions are about the same as in 1938 with the sawfly generally present but nowhere in epidemic proportions. Observations made during 1939 seemed to indicate several reasons for the increase of the sawfly on the periphery of the heavy infestations and a reduction at their centers in the southern part of New Hampshire and Vermont. There was such a tremendous larval population in the center of the heavy infestations in these areas that suitable larval food was exhausted comparatively early in the season and severe mortality occurred.

The progeny from larvae which did complete development found even less favorable food and mortality was often almost complete. Accompanying this lack of suitable food was the prevalence of disease which took not only an enormous toll where larvae were abundant, but also killed a high percentage of larvae in the older infestations where the larval population was low. On the periphery of the heavy infestation, although disease was prevalent, the abundance of food apparently insured the development of large numbers of larvae to the hibernating stage. Up to the present time there have been very few trees killed by the sawfly in southern New Hampshire, but the 1939 feeding included large numbers of "scattered spruce", i.e., trees growing among hardwoods. In general, these trees were more seriously defoliated than trees growing in spruce stands, and it seems probable that many will die. In southern Vermont there has been more mortality among trees heavily fed upon in 1937 and 1938, particularly on the edges of the infested stands. The percentage of killed trees has been very low, nevertheless. The majority of severely affected trees in this area grow in small but solid spruce stands. Under these conditions enough foliage has apparently been left in the crowns to insure the survival of most of the trees, if they are not severely attacked again in the immediate future.

Concentrated spray method gives effective control of the white pine weevil and the pales weevil. Concentrated spray applications effected nearly 100 percent control of these weevils at a cost of about $2.50 per acre for the white pine weevil and $1.50 per acre for the pales weevil. Lead arsenate and cryolite were the most effective insecticides tested. About 5 pounds of insecticide per acre is required for the white pine weevil and 1 pound for the pales weevil. Conventional spray methods are ineffective and too expensive. The equipment used for the application of the concentrates was very inexpensive and a minimum of labor was required.

Low population in gypsy moth ecological plots. Studies on the annual population density of the gypsy moth in three experimental areas where no artificial control measures are applied show that the population of the insect has either decreased to a low density or remained in a somewhat static condition at a low population level for the past three or four years. These three study areas represent a total of from 1,300 to 1,400 acres of infested woodland in Massachusetts and Connecticut. Cruise lines are run through these areas in the fall of each year and a measure of the population density secured by counting the egg clusters present in sample plots, 100 square feet in area, taken at regular intervals on the cruise lines.

In the study area on the Natchaug State Forest, Eastford, Conn., the insect has been exceedingly scarce for the past four years. The infestation in the 1,000 acre study area has been so low during this period that no egg clusters have been found in the hundreds of

sample plots examined. However, in traversing the cruise lines a special effort was made to find egg clusters and so far, a total of from 2 to 17 egg clusters have been found each year. The number of egg clusters found by this method were as follows: 1936, 4; 1937, 17; 1938, 2; 1939, 3.

The insect was abundant in about one-third of the 300-acre study area on the Freetown State Forest, Freetown, Mass., in the fall of 1937, hundreds of egg clusters being present per acre. However, comparatively little defoliation occurred in this area in the spring and summer of 1938. The population was reduced to a point where egg clusters were difficult to find in the fall of 1938, with only a half dozen occurring in over one hundred sample plots. This fall the population is still lower.

A 250-acre study area was set aside on the Harvard Forest, Petersham, Mass., during the winter of 1936-37 and population studies were made in the area until the fall of 1938, when it was abandoned because of the damage to the woodland resulting from the hurricane. In the fall of 1936 this area contained a fairly heavy population of the insect in a number of "pockets" where a dozen or more egg clusters might be found on individual trees. In the spring and summer of 1937 a number of trees were defoliated in these heavily populated "pockets". In the fall of that year the population was lower than in the preceding year but egg clusters were common throughout the area and there was one heavy "pocket" of about one-half acre in size where egg clusters were abundant. There was no noticeable defoliation in the area in the spring and summer of 1938 and egg clusters were scarce that fall. After the hurricane of September 1938, the above study area was abandoned and similar studies started in an adjacent infested woodland of about 60 acres. This area was well populated with egg clusters in the fall of 1938, there being approximately 500 per acre. There was no noticeable defoliation in the area in the spring and summer of 1939 and only three egg clusters were found in about 400 sample plots this fall.

Southern

On February 12 to 14, Dr. Craighead and Johnston visited the Ann Jordan Game Preserve, Coosa Co., Alabama, where there is a typical southern pine beetle infestation--in some places there have been very serious local outbreaks involving a number of acres. This outbreak has been going on for at least three years and would indicate severe drought in this area. A sawmill is now operating on this preserve to clean up the

infestation; tops and slabs are being burned as the timber is cut and sawed.

In cooperation with the Forest Service, additional tests of new chemicals to control the Texas leaf-cutting ant were installed or planned for the Kisatchie National Forest in Louisiana, February 19-20, by Snyder. Methyl bromide was again tested and dosages for other non-inflammable fumigants were decided upon so that these chemicals could be used with greater safety than by using carbon bisulphide.

Every effort will be made to continue the experiments on the control of powder-post and ambrosia beetles, being conducted by Christian at Tallulah, La., after July 1, when the lumber associations may be unable to continue financial support. Several chemical companies are making contributions.

Reinspections of the termite infested buildings treated with soil poisons about the foundations were continued by Johnston and Snyder. The results are being tabulated on 5 x 8 cards and a special report summarizing the results is being prepared. Dr. Verrall of Forest Pathology also inspected these buildings to note the presence and progress of wood rotting fungi. This is the second annual inspection.

PATHOLOGY
(In cooperation with the Bureau of Plant Industry)

Appalachian

Estimating Top Rot in Oaks. On the basis of 333 trees examined on commercial logging operations, a means of estimating the volume of top rot in oaks was devised. The trees were divided into 5 classes, depending upon the number or rotten stubs, wounds, or blind knots on the trunk. The average cull volume ranged from 3 board feet in trees with no rotten stubs or large wounds and less than 3 blind knots, to 218 board feet in trees with 4 or more rotten stubs or wounds or 8 or more blind knots. Top rot began to assume importance in the black oak group between 75 and 100 years and in the white oaks between 100 and 150 years.

Little-Leaf Disease. Marked deterioration of shortleaf pine, similar to the little-leaf disease of that species in Alabama, was found along the eastern edge of the shortleaf pine type in South

Carolina. Some deterioration was also found, in isolated areas farther toward the mountains, well inside the short-leaf type.

Northeastern

Paraphrasing an old saying, "The way of an exotic tree is a hard one", seems to be coming true with Douglas fir in the Northeast. It has been used quite successfully in southern New England and New York as an ornamental, and is being planted on a forestry basis. In the last two years it has become evident that a leaf-cast caused by Phaeocryptopus (Adelopus) gäumanni, known in Europe for several years, is present in New England. It has been found in all of the New England states. Whether some climatic factor favors its attacks is not definitely known, but seems probable. The serious aspect of this locally destructive disease is not here in the East but in the native stands of the West.

A new trouble, possibly rather serious, seems to be developing with the balsam fir. The fungus causing it is known as Rehmiellopsis bohemica. It has been known for a number of years on ornamental species of fir, especially Abies concolor. For several years what is believed to be the same disease has been known on native balsam fir in northern Ontario, where it is so scattering that it causes no damage. It has been found on native balsam fir in northern Maine, first at Eustis and later at Flagstaff. This last summer it was found generally distributed from these two points north eastward beyond Moosehorn Lake. There are severe centers where practically all the young twigs and leaves are attacked, even on good-sized trees. Severity seems to vary in a given place from year to year. How serious it will be over a number of years we cannot say. Potentially, it may kill reproduction and possibly older trees. If it should retard the growth of this competitor of the spruce, even in local areas, it might not be an unmitigated evil.

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